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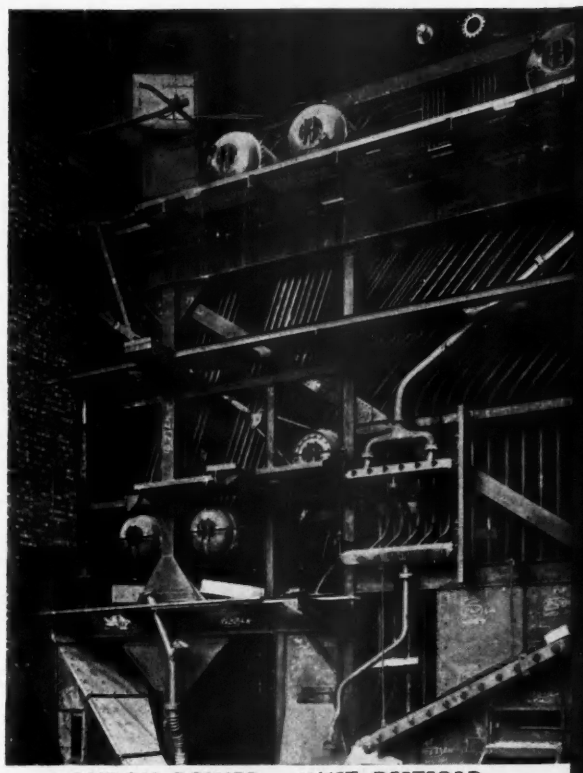

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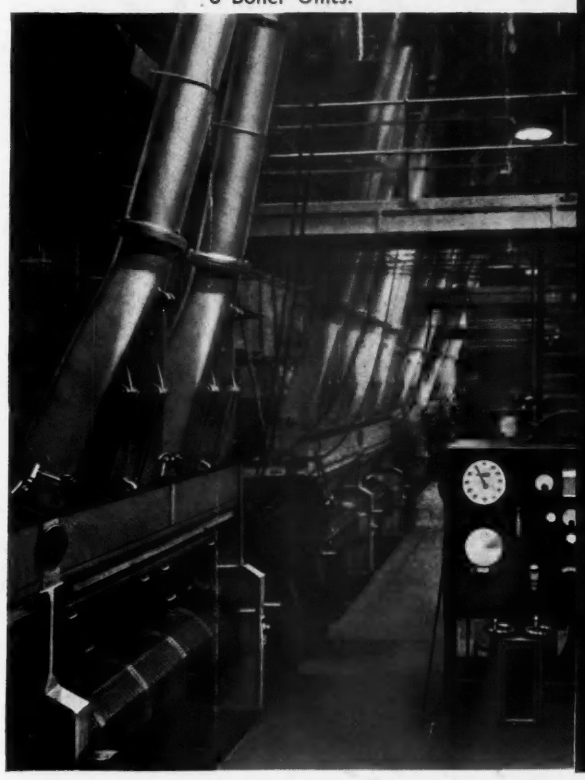

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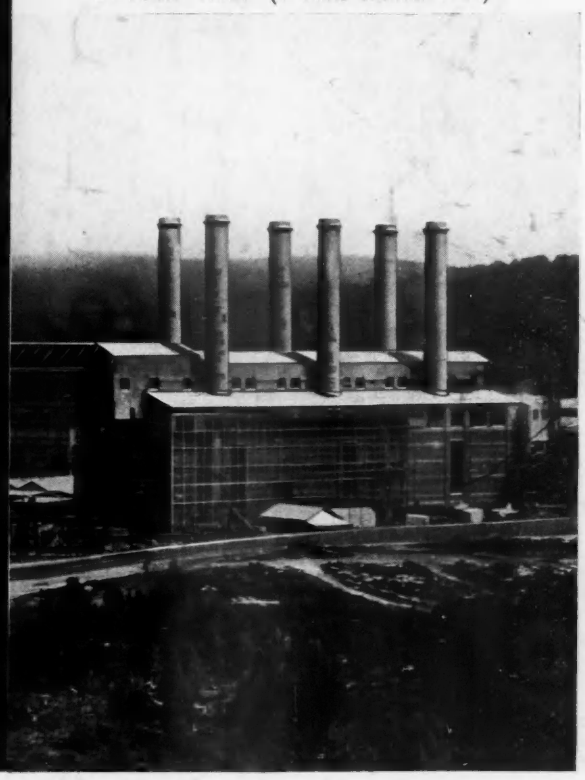

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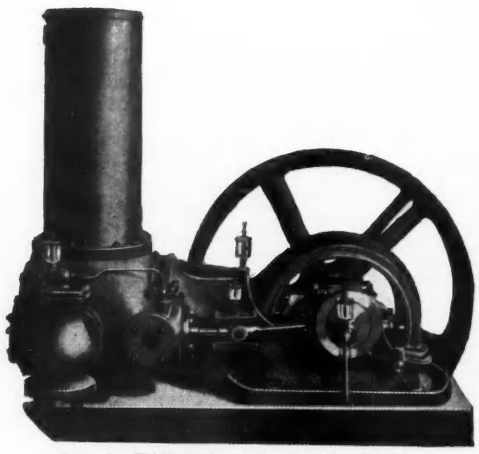

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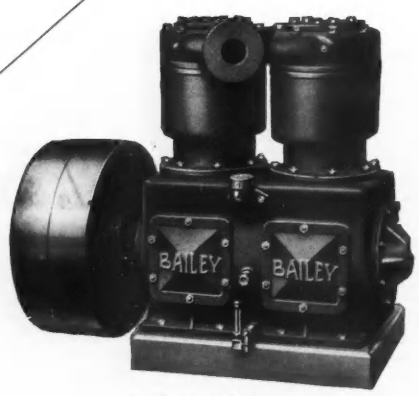

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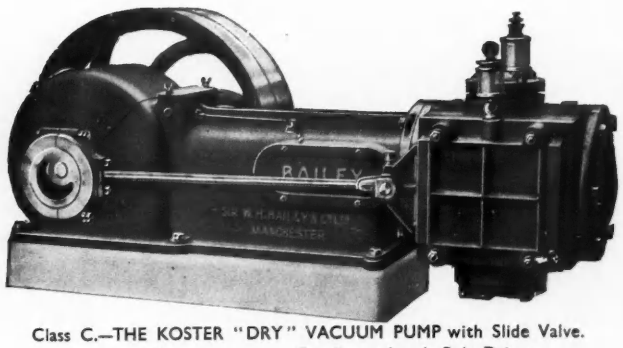

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A Seven-Day Journal

New Railway Electrification Schemes.

On Friday, August 2nd, it was announced that the Southern Railway Company had placed contracts to the value of several million pounds for electrical equipment, in anticipation of the future electrification of further sections of its railway system. The orders, which, it is understood, are to be spread over a period of ten years, have been entrusted to two companies, the English Electric Company, Ltd., and Asea Electric, Ltd. The first-named company will supply the Southern Railway Company's requirements for electric train equipment, while the second will supply all the railway company's requirements for high-tension switchgear, and remote control apparatus. The contracts placed are, we understand, amongst the largest of their particular kind ever placed in this country. They have nothing to do, it is stated, with the recently announced Government £32,000,000 scheme for railway electrification, but have been placed as part of the further development of electrification of the Southern Railway system, to be undertaken in consequence of the success of the company's London, Brighton, and Eastbourne schemes. The London and North-Eastern Railway Company announces its intention to electrify the 11-mile line between Newcastle-upon-Tyne and South Shields at a cost, including the modernisation of rolling stock, of over £500,000. About 5,000,000 passengers are now carried over this line per year, and steam trains in each direction at intervals of 20 minutes have been provided. By electrification it will be possible to reduce the duration of the journey from 33 to 34 minutes, to about 27 minutes. The new work will include modernisation of the whole of the rolling stock used on the North Tyneside lines.

The Fuel Oil Tax.

The new increase in the tax on fuel oil used in road vehicles, mentioned in a Journal note of April 19th last, came into force yesterday (Thursday), and has provided the Treasury with an unexpectedly large increase of revenue, as a consequence of the increase in the numbers of oil-engined vehicles in use. This increase was mentioned in a Journal note of July 26th, dealing with the returns of the Society of Motor Manufacturers and Traders, and it shows that, in spite of increased taxation, the inherent fuel economy of the modern oil engine has appealed to the owners of commercial transport vehicles. Prominent among such owners is the London Passenger Transport Board, which now has some 800 vehicles driven by oil engines. It is increasing that number at the rate of six or eight per week, and all new vehicles are to be fitted with oil engines, so that the entire fleet will gradually become oil engined. This programme involves about 6000 vehicles, whose average annual mileage is 50,000 per vehicle. The London Passenger Transport Board estimates that the new Budget is increasing its running cost by some £55,000 per annum at present, a sum which will increase as each new vehicle is placed on the roads. Nevertheless, it intends to continue the process of standardising oil engines on grounds of economy. The actual effect of the new tax on, for example, a 5-ton vehicle is that, in order to show an economy in favour of the oil engine, the vehicle must now average at least 22,000 miles per annum, whereas before the new tax came into force only 17,000 miles per annum was sufficient. These mileages are low compared with the normal running of commercial vehicles. The Commissioners of Customs and Excise desire to draw attention to the illegality of using, after August 8th, heavy oil fuel which has not paid duty. Full particulars of the operation of the new duty are given in Customs and Excise Notice No. 75.

The Reorganisation of British Industry.

In order to study the question of industrial organisation, the Federation of British Industries has recently appointed a Committee composed of Sir James Lithgow (Chairman), Mr. Peter Bennett, Mr. W. H. Catterall, Lord Melchett, Mr. C. W. Reeve, and Mr. H. B. Shackleton, to consider the question. The Committee's report has now been approved by the Grand Council of the Federation. Two avenues were followed by the Committee, the first being the suitability of the existing organisation of industry to meet present-day problems; and the second whether, if further co-operation was necessary, compulsory powers were needful, and, if so, what form these powers should take. It was decided that it was rare that voluntary association was not sufficient to cope with the needs of modern industry, but that a larger range of industry should combine to meet and negotiate with other interests and to organise its internal arrangements. While deprecating the compulsion applied to minorities and the too far-reaching effects of self-government schemes for industry, the Committee felt that Parliament should be used to assist industrial efficiency. This result would not be achieved were legislative methods used to hamper individual ideas and enterprise. Lord Melchett has added a minute to the report in which he disagrees with one point of procedure. The Committee considered that the use of an Order in Council to enforce the decisions of the majority of an industry "would be an undesirable addition to bureaucratic powers." In Lord Melchett's opinion this method of procedure is "most convenient and would further protect industries against the danger of their affairs being made the subject of party controversy in Parliament."

Explosives in 1934.

The annual report of his Majesty's Inspectors of Explosives for 1934—the fifty-ninth of the series—has now been published. In it is contained a record of the closing of the old Gunpowder Mills at Faversham of Curtis's and Harvey, Ltd., the regret of the Department being expressed at this break in a long historical tradition dating from the reign of Queen Elizabeth. With regard to accidents, the report has no serious irregularity in connection with licensed premises for the manufacture or storage of explosives to report, and no fatal or serious accident has occurred on such premises. A further warning as to the danger of unauthorised handling of explosives is given. A report was made as to the sensitiveness of materials used in the manufacture of aluminium alloy by the thermit process and their safest method of handling and working. Commenting on the use of gas traction, the report mentions the fact that for heavy lorries the oil engine has proved itself too formidable a rival for the gas-burning, low-compression engine to tackle, but it holds out some hopes for low-powered lorries in the "short-distance" field. As recorded in our issue on May 31st last, the Chesterfield Tube Company has submitted for test sample cylinders for use in house lighting by compressed gas. Investigation is also being made into the suitability of certain cylinders for filling with liquefiable gas, and of containers for the conveyance of sulphur dioxide and of bromine. In general, the report shows that although many preventable accidents have occurred, all have been outside the authority of H.M. Inspectors, who have maintained an admirable degree of safety wherever their control has operated.

The Central Electricity Board's Activities.

More information concerning the activities of the Central Electricity Board is desired by a group of supporters of the National Government, including Mr. Horobin, Sir Arnold Wilson, Sir Henry Cautley, Sir Robert Gower, Mr. Assheton, and Mr. Charles Williams. The following motion has accordingly been placed on the Order Paper of the House of Commons:—"That this House views with apprehension the secrecy surrounding the trading and financial operations of the Central Electricity Board in connection with the national grid, and considers that greater frankness and confidence in the public should be displayed, and that it is in the national interest that the Minister of Transport should exercise his powers under the Electricity (Supply) Act, 1926." It is suggested that the Minister should prescribe that the annual statement of accounts, should be such as to show clearly the purchase and sales of electricity in each area, and the average revenue per unit sold in each area. The Minister is also asked to prescribe that the Board's annual report should show clearly the actual basis underlying the financial provisions which are being made to meet out of revenue the interest on and redemption of capital, and the provision which is being made for renewals and obsolescences.

The Development of Civil Aviation.

Last week it was officially announced that the Prime Minister had appointed a committee to consider and report to the Secretary of State for Air upon measures which might be adopted by His Majesty's Government or by local authorities for assisting in the promotion of civil aviation in the United Kingdom and their probable cost. The committee will take into account the requirements of the Post Office for air mails and the relation between aviation and other forms of transport. The constitution of the committee is as follows:—Brigadier-General Sir Henry Maybury (chairman), Colonel Sir Donald Banks, Mr. J. A. N. Barlow, Sir Cyril Hurcomb, Sir Arthur Robinson, and Lieutenant-Colonel F. C. Shelmerdine. Mr. J. G. Gibson, of the Air Ministry, will act as the secretary to the committee, and any correspondence should be addressed to him at the Air Ministry, Gwydyr House, Whitehall, London, S.W.1.

An Italian Coalmines Institute.

In view of the national importance of the coal trade between Great Britain and Italy, the recent steps taken by the Italian Government to foster home-produced fuels will be watched with interest by British coalowners and shippers. According to the *Italian Gazette*, a new company, styled the Azienda Charboni Italiani, has been formed to take charge of the Italian coal industry. It will have a capital of about 50 million lira, or close upon £830,000, which will be officially provided by the State, although some 40 per cent. of this capital may be taken up by the banks and the insurance companies. The object for which the undertaking has been formed is stated to be the task of developing the search for and the production and sale of national pit coal. The new body is authorised to take over shares in companies which may be engaged in coal mining in Italy, and it may also establish and conduct selling agencies for the coal produced from the mines in which it is interested. The State is to make a grant of three million lira, or about £50,000, per annum over a period of nine years in order to assist the research work of the new institute. It is further officially stated that the Italian Government has decided to form a monopoly for the purchase abroad of coal, patent fuels, coke, copper and its alloys, either raw or scrap, tin in ingots, rods, and scrap, and nickel and its alloys in ingots, cubes, and scrap. The monopoly will be operated through the State Railways Administration and was to begin its functions on August 1st.

Motor Liner for Coastal Service.

A launch of unusual interest took place at the Leith yard of Henry Robb, Ltd., on Wednesday last, July 31st, when a new twin-screw motor vessel, the "Ocean Coast," took the water and was named by Mrs. Ratledge, the wife of Mr. James W. Ratledge, a director of Coast Lines, Ltd. The new ship is the third of four new vessels of a similar type which are being built by Henry Robb, Ltd., and it will be used on a bi-weekly service between London and Liverpool. The "Ocean Coast" has a length of 250ft. with a breadth of 38ft. and a depth of 22ft. 9in. and a deadweight carrying capacity of 1700 tons. Her propelling machinery will comprise a twin-screw arrangement of two 750 b.h.p. "Atlas" oil engines, which will give her a designed speed of 12 knots. It is confidently anticipated that the new vessel will exceed her designed speed and will thus become the fastest British coastal liner afloat. In addition to large cargo holds with electrically operated lifting gear, the "Ocean Coast" has twelve single-berth cabins with public rooms and state-rooms. The auxiliary machinery includes air conditioning plant for public rooms, while among the navigating equipment there is an automatic depth recording apparatus and a complete wireless telegraphy apparatus for communication with other ships and with shore stations. The design of the ship and its propelling machinery has been supervised by Mr. William Roxburgh, the engineer-in-chief of Coast Lines, Ltd., and his assistant, Mr. Braidwood, who have collaborated with the technical staff of Henry Robb, Ltd.

Wages in the Shipbuilding Trades.

A joint conference of the Committee of the Shipbuilding Employers' Federation and representatives of the shipbuilding trade unions recently took place in Edinburgh, when the wages position was fully discussed. The chair was taken by Mr. C. S. Swan, the vice-chairman of Swan, Hunter and Wigham Richardson, Ltd., on behalf of the employers. The unions' case in support of an advance of 2d. per hour with an equivalent advance to pieceworkers was presented by Mr. Westwood, of the Shipwrights' Society, who is President of the Federation of Engineering and Shipbuilding Trades and by Mr. John Hill, of the Boilermakers' Society. It was claimed that since the preliminary conference held in May the industry had improved and that the present prospects justified the grant of an immediate advance in wages. In his reply Mr. Swan informed the union representatives that in accordance with the usual procedure the men's statements would be circulated to the shipbuilders and the application further considered at an early meeting of the governing body of the Federation. An opportunity was taken of the presence of the unions' representatives to have a discussion on the working of overtime in shipyards, and the desirability of all possible steps being taken to remove difficulties and reduce overtime working to the least possible minimum. It was mutually agreed that the conference be resumed at an early date to receive the employers' reply on the question of wages.

The Unemployment Figures.

According to a statement issued by the Ministry of Labour on Tuesday, August 6th, it is estimated that on July 22nd, 1935, there were approximately 10,381,000 insured persons aged 16–64 in employment in Great Britain. This was 20,000 more than a month before and 234,000 more than a year before. Among the leading industries in which an improvement in employment has been recorded we note the engineering, iron and steel, and motor vehicle industries, electric cable and apparatus manufacture, the woollen and worsted and hosiery industries, the transport and distributive trades, and hotel and boarding-house services. There was also a reduction in the numbers unemployed in the coal-mining industry. On July 22nd, 1935, the numbers of unemployed persons on the registers of employment exchanges in Great Britain were 1,501,226 wholly unemployed, 393,198 temporarily stopped, and 78,517 normally in casual employment, making a total of 1,972,941. This was 27,169 less than the number on the registers on June 24th, 1935, and 153,319 less than a year before. The total on July 22nd, 1935, comprised 1,584,554 men, 58,034 boys, 281,712 women, and 48,641 girls. The reduction in unemployment recorded in the figures above given is noteworthy, in that for the first time in five years the number of registered unemployed in Great Britain on July 22nd, was below 2,000,000.

Bouquet Canyon Reservoir and Pipe Line.

BOUQUET CANYON RESERVOIR, the newest unit of Los Angeles' far-flung water supply system, is now filling for the first time. This reservoir, with its associate features, is of special engineering interest.

Five years ago, the citizens of Los Angeles voted to expend about 39,000,000 dollars to amplify the city's water supply by tapping a basin high in the Sierra Mountains 275 miles, by air line, nearly due north. Since then, the project has been actively pursued. The largest remaining items of the programme to be carried out are the driving of an eleven-mile tunnel through a mountainous divide to link the Mono Basin with the upper watershed of the Owens River, and certain auxiliary dams. Water from the Mono Basin will increase the water supply of Los Angeles by quite 38 per cent. and reduce proportionately the existing excessive draught on underground reserves, for some while threatened with exhaustion. The water from Mono Basin is the product of melting snow and ice, and carries on an average only 2·52 grains of solids per U.S. gallon.

Up to two years ago, the city had spent 55,000,000 dollars on its notable aqueduct, designed to carry 480 cusecs of water, but at no time delivering more than 450 cusecs. The completion of the Mono Basin project will make it possible to operate the aqueduct at capacity. Water from the mountains will reach Los Angeles by gravity flow, and in its course southward will have an effective head of about 4000ft., which will be utilised to generate electricity. The rainfall of Southern California is extremely variable, and there have been recurrent protracted periods of two or more decades of deficient precipitation. An ample supply of water is indispensable to so many of the activities that contribute largely to the industrial and economic life of the section.

When the St. Francis Dam suddenly failed in March, 1928, Los Angeles was deprived of 38,000 acre-feet of nearby storage capacity—more than half of its available reserve. The Bouquet Canyon Reservoir has recently been completed to relieve the

FIG. 1—TESTING SOIL AFTER PASSAGE OF ROLLERS

critical situation, and is part of the general scheme authorised in 1930. This reservoir—see Fig. 4—is approximately 40 miles due north of the city, and is capable of impounding 38,800 acre-feet. It occupies a deep and narrow gorge about 4 miles to the eastward of San Francisquito Canyon, through which the Los Angeles-Owens River Aqueduct runs southward to the municipality, and connects with the aqueduct by a welded steel pipe line 18,200ft. long, which traverses a rugged mountainous region.

Bouquet Canyon Reservoir is formed by two earth-and-rock-fill dams. The main dam rises 185ft. above the original ground surface of the site, has a traverse spread at its base of 1200ft., a crest length of 1200ft, and a top width of 50ft. The top of the dam will be 10ft. above the maximum surface of the lake. The local watershed contributes but little to the contents of the reservoir. The dams of the Bouquet Canyon Reservoir reflect experience acquired in rearing four other dams of similar type, and all these structures are the result of researches instituted by the Bureau of Waterworks and Supply of Los Angeles. The engineers of that organisation do not believe that the pervious materials employed in earth-fill dams should be used principally to furnish support by their weight alone to the impervious upstream part of such structures. They have, therefore, adopted the theory that structural stability should be assured by systematically compacting substantially 75 per cent. of the earth-fill materials used so as to render them impervious.

The Bureau has evolved means for the quick testing of materials in the laboratory, at or near a dam site, and also during the actual rolling of the earth *in situ*. It is now practicable, in this way, to avoid the use of materials that may be deficient in their resistance to percolation. One of the instruments developed for field service is a simple tool that is known as the soil plasticity tester—the essential features of which are indicated by Fig. 5. As the plasticity needle is forced into the ground, compressing a calibrated spring, the effort to effect penetration is registered by a scale on a piston-rod, which carries a movable indicating clip. At the Bouquet Canyon Reservoir, the needle was used to evaluate the soil obtained from a neighbouring borrow pit and to test the compacting of the soil during the different stages of constructing the two dams—see Fig. 1.

When the physical characteristics of the available soil had been determined, then the material was moistened, as prescribed, before being compacted in place. The moisture was counted upon to facilitate compacting, and sheep's-foot rollers—see Fig. 6, p. 144—of the Bureau's own design, were used to bring about thorough compaction. The kneading action of these rollers effects greater density of the soil than is commonly obtainable with the more familiar wheel-type roller. The rollers were sometimes used in sets of three having a combined weight of about 12 tons, and they were pulled by a tractor of 65 h.p. The feet of the rollers could apply a unit pressure of 200 lb. per square inch.

All unconsolidated material was cleared away by power shovels down to solid bed rock at the site of the main dam, and further cleaning to bare the rock was done by hand. The stream bed was excavated to a depth of from 30ft. to 50ft. Soil and weathered rock, at the abutments, were removed to a depth of from 10ft. to 30ft. Of the 771,000 cubic yards of material thus stripped, substantially 434,000 cubic yards were worked into the downstream body of the main dam. The soil immediately in contact with the foundation rock and the abutments was compacted with pneumatic tampers. Elsewhere, the earth was spread with bulldozers in layers averaging 9in. thick, and then compacted by the rollers to a thickness of 6in. Before rolling, the material was sprinkled and the soil at the borrow pit was moistened there before transfer to the dam sites. The rollers passed from sixteen to twenty times over a layer to assure acceptable compaction.

The pervious downstream section of the main dam was constructed simultaneously with the impervious section. The pervious section of the dam is composed of 750,000 cubic yards of material, while the impervious fill is made up of 2,125,000 cubic yards. At the upstream toe of Dam No. 1 a cut-off trench was excavated to a depth of from 10ft. to 20ft. and filled with concrete compacted with pneumatic vibrators. After the cut-off wall was poured two rows of grout holes on 10ft. centres were drilled parallel with the upstream toe. The holes, which ranged from 30ft. to 200ft. deep, were grouted with a cement mixture containing from 10 to 20 per cent. of bentonite, the bentonite being added to arrest any tendency of the cement to settle. The upstream face of Dam No. 1 is protected by a reinforced concrete slab, 9in. thick at the lower part and 6in. thick thence to the crest.

Dam No. 2, at the western side of the reservoir, closes a depression in the ridge that walls in the reservoir there. That dam has a maximum height of only 42ft., a crest width of 30ft., and required only 40,000 cubic yards of stripping and the placing of 136,000 cubic yards of fill. The fill was treated and rolled in the same manner as the corresponding work done on Dam No. 1.

The spillway of the Bouquet Canyon Reservoir is a vertical shaft of 8ft. internal diameter with a belled-out intake 16ft. in diameter. The spillway shaft is of reinforced concrete and merges at the bottom into a rock-driven tunnel which is lined with concrete. The spillway has a maximum discharge capacity of 1600 cubic feet per second, and at the intake there is a radial vane at one side of the lip, which serves to arrest the formation of vortex currents. There is an inlet-outlet tower—Fig. 2—at the western part of the reservoir. This is provided because the reservoir receives nearly all its water from the aqueduct during stages of abundant flow and returns to the aqueduct a compensating volume of water when the flow above the point of connection is deficient to meet requirements. The inlet-outlet tower is connected directly to a pressure tunnel, 1027ft. long, which has an internal diameter of 8ft. That tunnel, in turn, is linked with the 3½-mile steel pressure pipe line. The pipe sections are from 80in. to 94in. in outside diameter and made up of plates varying from ¾in. to 1 1/16in. in thickness. At the bottom of San Francisquito Canyon the hydrostatic head is 870ft. The heavy pipe sections are 20ft. long and the lighter sections 30ft. long. The unit sections were shop welded by machine in Los Angeles and transported by motor trucks. All the joints in the field were welded by hand.

Because of the conformation of the ground on which the pipe line rests eighty-odd bends were shop fabricated by hand welds. They have curvatures

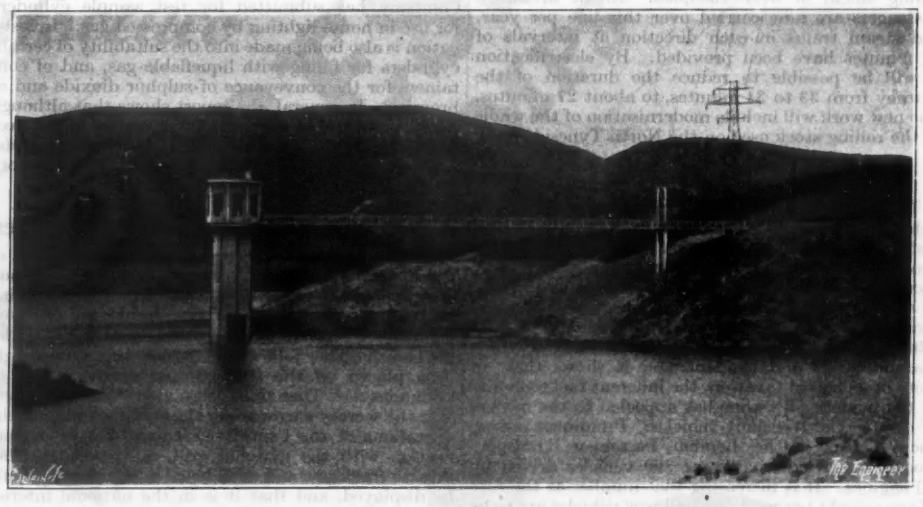


FIG. 2—INLET-OUTLET TOWER OF RESERVOIR AND GATE CONTROL HOUSE

ranging from 3 deg. 44 min. to 47 deg. 54 min. All were designed to have an outside radius of 23ft. The motor trucks moved the pipe sections a distance of about 50 miles from the shop to the field base at the bottom of the San Francisquito Canyon, where each section was sand-blasted inside and out and then coated. The inside surface was first covered with coal tar primer and a day later was finished with a coat of hot coal tar enamel. The outside of each section first received a coat of synthetic red lead, and when the field welding was completed the exterior was given a coat of white enamel. The final outside finish was a coat of synthetic aluminium paint. A force of twenty-seven men did all the welding in the field. Connections were made by means of one or other of two types of circumferential joints. Pipe sections formed of ¾in. or ⅝in. plates were given plain ends and one end was afterwards rolled to form a bell to receive a contiguous plain end, which was thus overlapped 1½in. Pipe sections of greater thickness were bevelled for field welding, and in the field such joints were fitted with semi-circular butt straps—see Fig. 9—the two half straps on contiguous sections being welded in the field to form a unified circumferential reinforcement.

Because of the roughness of the country crossed by the pipe line it was necessary at some ridges to cut trenches 20ft. deep to keep the pipe tangents as long as practicable and to have as few bends as possible. Elsewhere the conduit was carried just above the ground either on concrete piers or steel bents, the latter having a maximum height of about 20ft. where small canyons were spanned. Generally, the pipe line rests on concrete piers, one pier under each pipe section, and the maximum distance between piers is 27ft. The concrete piers have a maximum height of 5ft. and their use, wherever practicable, has provided the most economical support.

At three points in the pipe line there are expansion joints, one on the east side and two on the west side of San Francisquito Canyon. Elsewhere an anchor block is installed at each bend to translate into longitudinal stresses the effects of temperature changes. These anchors are relied upon to restrain movements resulting from temperature variations of from 10 deg. to 120 deg. Fah. The welds which closed each tangent were made when the atmospheric temperature was between 55 deg. to 60 deg. Fah. With the conduit filled with water the shell temperature is not likely

to rise at any time above 80 deg. Fah. According to the Chief Engineer of the Bureau of Waterworks and Supply, H. A. Van Norman, "The combined thrust caused by hydrostatic pressure, a temperature rise of 20 deg. or 25 deg. Fah. and the tendency to shorten longitudinally, due to hoop tension, will be less than that produced by a temperature rise of 65 deg. Fah. when the pipe is empty."

Except near the expansion joints in San Francisquito Canyon, the anchorage at each bend is made up of a cage of bars of reinforcing steel bent to conform

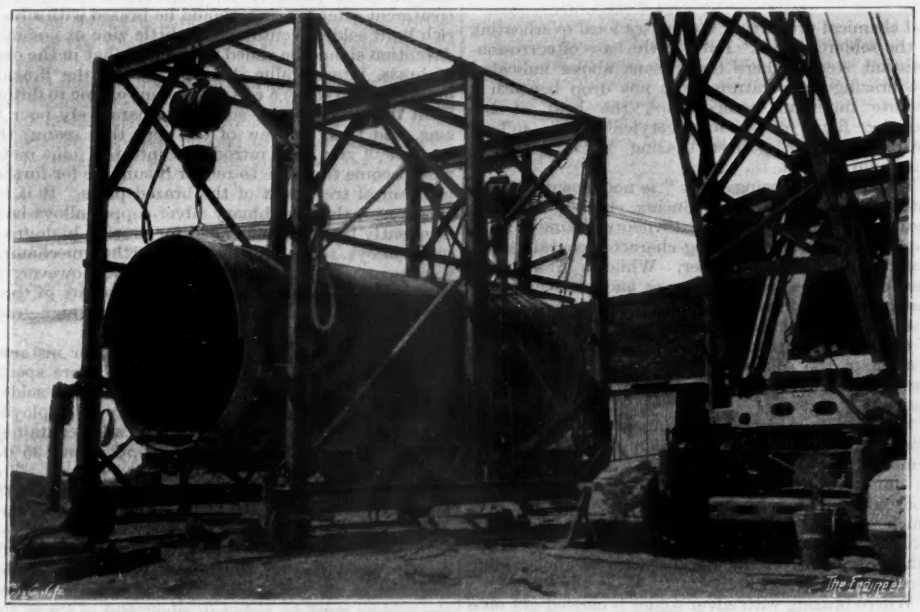


FIG. 3—CARRIAGE WITH TWO AIR HOISTS FOR TRANSPORTING PIPE SECTIONS

to the upper half of the pipe elbow and grouted into the underlying rock. The bars are embedded in concrete that has, over the top of the pipe, a thickness of not less than 12in., and the concrete is formed on the rock into which the reinforcing bars are grouted. At points in San Francisquito Canyon, and at lower elevations than the expansion joints there, the vertical bends are anchored by steel saddle plates placed over the pipe elbows and welded to reinforcing bars that are grouted into the rock. There are five of these anchors and they are counted upon to hold the bends against the computed maximum hydrostatic thrust and yet permit some longitudinal movement in the tangents. Close to the middle of each of the five tangents that exceed 500ft. in length there is an additional anchor that is designed to restrain the pipe from being forced out of alignment by so-called "column action."

The heaviest of the unit pipe sections weighed close to 10 tons, and special handling facilities were provided to place them in the field, particularly on steep hillsides where the slope exceeds 45 deg. Installing was started at the bottom of San Francisquito Canyon, where the heaviest of the pipe sections had to be placed to meet a hydrostatic head of 870ft. A track having a gauge of 9ft. 10in. and resting on wooden ties was laid along the centre line of the prescribed route, and on that track was moved a steel carriage—Fig. 3—within which each pipe section could in turn be suspended. The framework of the carriage straddled the track and also the pipe section to be lifted by slings pendant from two 5-ton pneumatic hoists secured to cross beams at the top of the carriage. Thus a pipe section could be picked up from the ground, raised high enough to clear the cradles of the concrete piers and then moved to a given position and lowered on to its permanent supports with precision. At the top of a given slope a 100 h.p. electric hoist was set where it could control by cable either the ascending or descending movement of the carriage. The common practice was to transport by motor truck each pipe section from the receiving yard to the shelf or top of each slope, and thence to lower the pipe sections as the conduit was gradually extended uphill. On the flatter parts of the conduit route and where the lighter pipe sections had to be handled the foregoing procedure was modified. Despite the mountainous nature of the country traversed and its comparative remoteness, the work was carried forward rapidly. A force of less than 700 men, working 5½ days a week and in two eight-hour shifts per diem, completed the entire undertaking in but a little more than two years.

Under the supervision of the Bureau of Water Works and Supply, which was in control of the construction organisation, Bouquet Canyon Reservoir and the associate pipe line entailed a total expenditure of substantially 4,000,000 dollars.

The pipe line, at its western end, connects with two of the penstocks that deliver water from the Los Angeles Aqueduct to San Francisquito power plant No. 1. That power plant is one of a number that utilises the aqueduct water to generate current which is used to operate the pumps that lift water from the deep wells which contribute so largely to Los Angeles' water supply. Whenever the full flow from Fairmont Reservoir is not required at the power-house, then any excess water is diverted into the Bouquet Canyon Reservoir. On the other hand, if the discharge from Fairmont Reservoir be short of requirements, Bouquet Canyon is in a position to make up the deficiency, especially at periods of peak load demand upon the San Francisquito power plant. There is a hydraulic

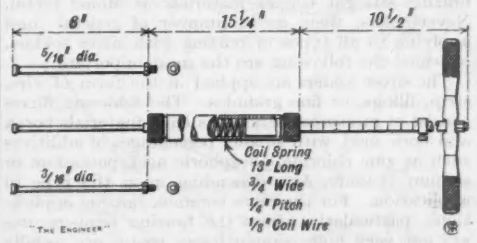


FIG. 5—SOIL-PLASTICITY TESTER

gradient between Fairmont Reservoir and Bouquet Canyon Reservoir that will induce in the pipe line a minimum flow of 300 cubic feet per second towards Bouquet Canyon Reservoir, and from the latter reservoir at least 450 cubic feet per second can be withdrawn to energise the power plant and to add to that extent to the city's water supply. Valves at each end of the pipe line make it possible to open or to close the conduit as desired.

At the bottoms of the thirteen low points in the pipe line there is at each a blow-off valve for unwatering the conduit. With the exception of the 12in. valve provided at the lowest point in San Francisquito Canyon, all other valves are of 8in. diameter. On the summits, near the blow-off valves, there are air and vacuum valves, which are designed alternately to serve to prevent the entrapment of air or the formation of a troublesome vacuum. At strategic points in the system there is apparatus for measuring head losses, flow, and pressures.

The Bouquet Canyon undertaking was designed and carried to its consummation under the direction of H. A. Van Norman, chief engineer, with the assistance of W. W. Hurlbut, engineer of waterworks; Henry L. Jacques, construction engineer; C. E. Angilly, engineer-in-charge of designs and specifications; and R. R. Proctor, responsible for the field engineering.

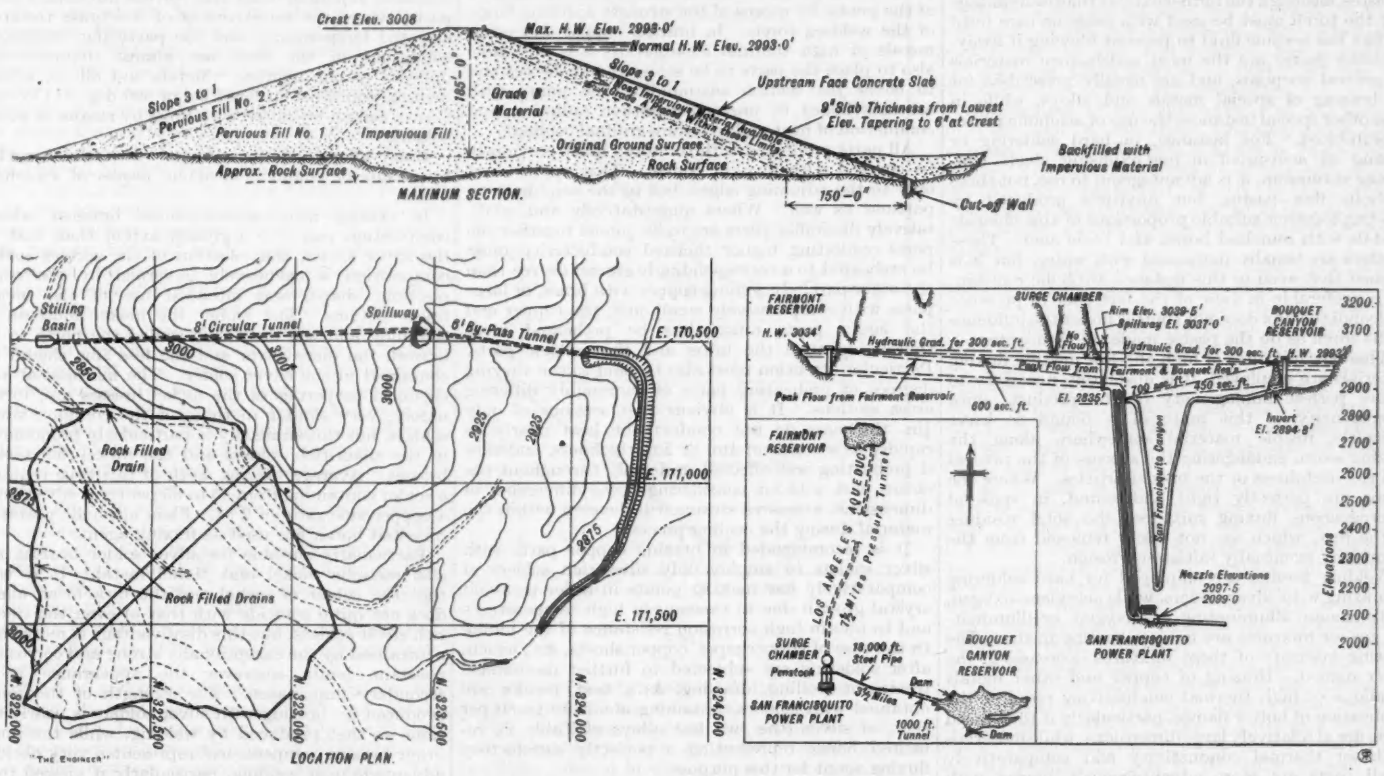


FIG. 4—MAXIMUM SECTION OF DAM, PLAN OF DAM SITE, SPILLWAY, AND STILLING BASIN AND PROFILE OF RESERVOIR

AN attempt is to be made by the Soviet Government to establish a meteorological station at the North Pole.

Production and Application of Silver Solders.

By EDMUND R. THEWS.

No. II.

(*Concluded from page 114, August 2nd*).

THE method of application of silver solders is governed in the first place by the character of the base metal and by the requirements to be fulfilled by the brazed parts. It is obvious that the properties of the solder seams of acid-proof special steels will have to differ from those of brass parts, and that different methods of application must be adopted in brazing straight copper materials or Monel metal. Nevertheless, there are a number of general rules applying to all types of brazing with silver solders, of which the following are the most important :—

The silver solders are applied in the form of wire, strip, filings, or fine granules. The soldering fluxes consist of mixtures carrying as chief materials borax and boric acid, with smaller percentages of additives such as zinc chloride, phosphoric acid, potassium or sodium cyanide, &c., depending upon the type of application. For the more common brazing applications, particularly where the brazing temperatures are not very high, simple borax pastes are usually employed. Wherever the brazing temperatures have to be raised for one reason or another, it is necessary to raise the fusion temperatures of the fluxes accordingly by increasing the percentages of boric acid contained. Table III shows the melting temperatures of the basic borax-boric acid mixtures :—

TABLE III.

	Deg. Cent.
Borax, pure	1400
75 per cent. borax, 25 per cent. boric acid	1500
50 per cent. borax, 50 per cent. boric acid	1520
25 per cent. borax, 75 per cent. boric acid	1535
Boric acid, pure	1600

Borax is entirely satisfactory for most purposes, and the more expensive boric acid is not nearly as suitable if applied in the pure state, even if its melting and flowing temperatures would not be too high for most purposes. It appears that its sole purpose as silver solder fluxing material is to suppress the excessively low-flowing temperature of borax and to ensure the production of a sufficiently viscous and protective layer at the higher brazing temperatures in question.

The fluxes can be employed in the form of powders or pastes, although the former exhibit the disadvantage that the torch must be used with extreme care until the flux has become fluid to prevent blowing it away. Alcoholic pastes are the most satisfactory materials for general purposes, and are usually prescribed for the brazing of special metals and alloys, while in some other special instances the use of alcoholic pastes is prohibited. For instance, in hard soldering or brazing of acid-proof or non-oxidising steels containing chromium, it is advantageous to use, not these alcoholic flux pastes, but mixtures produced by grinding together suitable proportions of zinc chloride crystals with remelted borax and boric acid. These powders are usually moistened with water, but it is claimed that even in this instance alcoholic moistening is preferable in view of the fact that in presence of alcohol the flux does not sputter under the influence of the torch as do the pastes made up with water.

Wherever mixtures of high and low melting fluxing materials are employed, it is absolutely necessary to ensure perfect homogeneity of the product, since heterogeneity of this material is bound to leave difficultly fusible material somewhere along the brazing seam, endangering the success of the process and the usefulness of the brazed articles. Where the seams are perfectly tight and sound, in spite of heterogeneous fluxing mixtures, the solid residues of the flux, which are not easily removed from the seam, may eventually initiate corrosion.

Welding torches are employed for hard soldering or brazing with silver solders, while acetylene-oxygen, acetylene-air, illuminating gas-oxygen, or illuminating gas-air mixtures are used as heating media. The heating intensity of these mixtures decreases in the order named. Brazing of copper and other metals or alloys of high thermal conductivity requires the application of hotter flames, particularly if the brazed parts are of relatively large dimensions, while materials of lesser thermal conductivity and comparatively small parts are more advantageously brazed with softer flames in order to prevent superheating or burning of the seams. Oxidising flames should be avoided even in the case of copper parts, although these are sometimes recommended in order to attain maximum thermal efficiencies. It is absolutely wrong policy to view all industrial processes from the standpoint of thermal efficiency, and since the silver solders are usually employed for high quality brazing, where mechanically and chemically sound seams are of high importance, the matter of thermal efficiency is of secondary importance only. Excessive application of heat is bound to deteriorate the quality not only of the solder itself, reducing its mechanical and chemical properties, but causes local overheating of the soldered parts. Even in the case of corrosion-resistant steels, where for reasons above indicated the brazing temperature must not drop beneath a definite minimum temperature, the heat of the reducing flame of an oxy-acetylene torch suffices entirely to give perfect brazing joints within a minimum of time.

The term "reducing flame" is not meant to indicate a flame of strong reducing character. Ideal results are obtained only with neutral flames, since flames of definitely reducing character contain gases absorbed by the fluid solder. While in view of the shortness of the brazing process, and on account of the protecting fluxes employed, the danger of gas absorption is not very pronounced, and while part of the gases absorbed are liberated during the solidification of the solder, it is advisable to avoid this danger as much as possible by brazing with neutral flames.

However, it is exceedingly difficult under practical working conditions to maintain an absolutely neutral atmosphere. Even the expert welder can never be quite certain that his torch is neither reducing nor oxidising in character, and since the latter is much more deteriorating than the former, it is advisable in any case to be on the safe side by maintaining a slightly reducing character of the welding torch.

Where brazing with silver solder is carried out on a large scale, it is good policy to preheat the parts to almost brazing temperatures in a special preheating furnace, constructed so as to avoid direct contact of the parts with the furnace atmospheres (firing gases), and to protect them further by the introduction of neutral gases, such as hydrogen, nitrogen, &c., as the case may be. This preheating treatment prevents the formation of internal strains due to the local heating of the torch and ensures maximum uniformity of the entire structure of the welded parts.

If preheating furnaces of this type are not available, or if the scope of work is not sufficiently large to justify their installation, it is necessary at least to preheat the parts, or the immediate neighbourhood of the joints, by means of the strongly reducing flame of the welding torch. In brazing copper and other metals of high thermal conductivity it is advisable also to place the parts to be soldered on asbestos and to cover the section surrounding the joints with asbestos board to prevent excessive radiation and conduction of heat and to ensure gradual cooling.

All parts preheated with the torch must previously be covered with flux, of course. This applies, not only to the adjoining edges, but to the neighbouring portions as well. Where quantitatively and qualitatively dissimilar parts are to be joined together the parts exhibiting higher thermal conductivity must be preheated to a correspondingly greater degree than the other part. In joining copper with brass, or large parts with comparatively small ones, the copper and the larger parts must thus be preheated more thoroughly than the brass and the smaller parts. Particular attention must also be paid to the varying degrees of preheating parts of thoroughly differing cross sections. It is obvious that sections of only ¼in. thickness do not conduct the heat nearly as rapidly as sections of 1in. or 2in. thickness, and that if preheating was effected uniformly throughout the entire part without considering these differences of dimensions, excessive strains will develop within the material during the cooling process.

It is recommended in brazing copper parts with silver solders to employ only silver-rich solders of comparatively low melting points in order to avoid crystal growth due to excessively high temperatures and to obtain high corrosion resistance of the joints. In the case of copper pipes, copper sheets, &c., which, after soldering are subjected to further mechanical treatment (rolling, drawing, &c.), best results are obtained with solders containing about 70 to 80 per cent. of silver (the two last alloys of Table I), remelted borax representing a perfectly satisfactory fluxing agent for this purpose.

The lower the zinc contents of the solder, the higher is the corrosion resistance of the soldered joint, but since this element is required to ensure satisfactory thermal properties, a certain minimum percentage of zinc must be maintained in all silver solders.

A very difficult problem in soldering thin-walled copper sections is the accurate regulation of the heat supply. The pronounced heat-conducting properties of copper on one hand, and the limiting influence of the thinness of the section on the actual heat conduction on the other hand, render the material very sensitive towards burning, and very slight degrees of superheating are bound to yield more or less pronounced burning phenomena accompanied by appreciable deterioration of the mechanical and chemical properties, as well as of the binding qualities of the joint. It is for this reason that no definite soldering or brazing temperatures can be recommended. It is necessary in all instances before brazing a large quantity of copper sections of this type to carry out a number of tests and to examine the joints as to their mechanical and chemical properties.

The above observations for copper apply to high-grade brass brazing as well. Thin-walled, stamped parts, as well as rolled, drawn, and forged sections, and all brass parts to be subjected to mechanical treatment after brazing, should be brazed with silver-rich hard solders containing as little zinc as possible. Attention should be called to the fact that in the case of brass, intermetallic diffusion during the brazing operation will cause a certain amount of zinc to diffuse from the brass to any solder comparatively poor in zinc, and that, in view of the very thin seams, the amount of zinc thus introduced into the joint metal may become too large to render it suitable for further mechanical treatment of the brazed parts. It is for this reason that the binary silver-copper alloys have frequently been recommended for brazing high-grade brass alloys to be subjected to further mechanical treatment. This suggestion is faulty, however, in that it does not consider the melting points of these alloys, which are entirely too high for high-grade brass joining.

For common brass brazing purposes, for instance, for joining heavy brass castings, &c., where special corrosion resistances are not specified, silver solders with as low as 20 per cent. of silver may be employed. A satisfactory solder of this type is an alloy containing 20 per cent. silver, 45 per cent. copper, and 35 per cent. zinc, which fuses at about 1500 deg. Cent. This temperature is not too high to cause burning of the joint if the operation is carried out with due care, particularly in the case of relatively heavy cast material where the large cross sections ensure sufficiently rapid flow of the heat. Where thin-walled material of the commoner type of brass is brazed, the solders must be richer in silver and of lower zinc contents, a fair proportion for silver : copper : zinc being 3 : 2 : 1. Average brazing work requires a solder containing about 45 to 55 per cent. of silver, the copper-zinc contents exhibiting a ratio of approximately 2 : 1. If brass alloys are to be joined with parts consisting of other metals or alloys it is advisable to employ solders of somewhat higher silver contents, although it is necessary in such a case to adapt the silver contents and the other composition ratios of the solder to the requirements of that part requiring the highest silver content and expected to meet the most exacting properties.

Very difficult conditions of this type prevail, for instance, in joining brass with corrosion-resistant steel parts, where the sensitiveness of the brass towards elevated temperatures and the particular structural conditions of the steel are almost diametrically opposed to one another. Metals and alloys, whose melting points are situated below 800 deg., (1475 deg. Cent.), cannot be united with brass by means of silver solders.

Brass alloys can be soldered with silver solder by means of common alcoholic pastes of remelted borax.

In brazing nickel-silvers (nickel brasses), whose composition varies to a greater extent than that of the silver solder, the selection of the correct solder composition is exclusively governed by the composition, shape, and intended use of the nickel brass sections. The higher the nickel contents of the alloy and the more thin-walled the parts to be brazed, the more silver and the less zinc should be contained in the silver solder. The mechanical and chemical properties of the nickel brasses are, fortunately, very similar to those of the common silver solders, but this similarity is particularly pronounced in the silver-rich solders and the nickel-rich nickel brasses. Average brazing work of this type requires a solder containing from 55 to 65 per cent. silver, with a copper-zinc ratio of 2 : 1. Plain alcoholic pastes of remelted borax are used as fluxing agent.

Particularly suitable for silver solder brazing are also metallic nickel and Monel metal. It is true that the colour of nickel and the nickel-rich alloys does not quite coincide with that of even the silver-rich silver solders, but this disadvantage is more than neutralised by the exceptionally strong and corrosion-resistant joints wherever the appearance is of secondary importance. The strength of the joints produced by brazing with silver solders is nearly the same as that produced by welding, while the much lower brazing temperatures represent a very decided advantage over welding, particularly if viewed from the corrosion angle. However, satisfactory results can only be obtained if the heating and cooling of the seams are carried out gradually in order to avoid temperature cracks and heating strains. Silver solder joints of nickel and nickel-rich alloys are very resistant towards many of the weaker acids and acid solutions, as well as towards most of the alkaline and neutral salts. Apart from their application in all branches of the chemical industries, they give very good results in connection with parts used in ice and low-temperature apparatus, as well as in steam plants (for turbine blades, &c.).

It is to be noted in this connection, however, that

Monel metal and a number of similar compositions are rather sensitive towards temperatures above 1475–1500 deg. Cent., so that silver solders of comparatively low flowing points should be employed. Average silver solder compositions employed for this purpose are: 65 to 70 per cent silver, with a copper-zinc ratio of 3 : 1 The 70 per cent. solder should, therefore, contain, besides 70 per cent. silver, 22 to 23 per cent. copper and 8 to 7 per cent. zinc. This solder melts at about 1375 deg. Fah. The 65 per cent. alloy should contain from 26 to 27 per cent. copper and 9 to 8 per cent. zinc, melting at a temperature of about 1350 deg. Fah. It is absolutely necessary to make liberal use of the fluxing agent (alcoholic borax paste), applying it not only to the edges of the joint, but to the neighbouring surfaces as well.

The most difficult materials to braze with silver solder are the acid-proof and rust-proof steels. Many of the structural problems relating to these steels have not been cleared up in connection with the influence exerted by the silver solders, particularly as regards the suitable period of brazing within the process of manufacture. For instance, if the finish treated parts are brazed with silver solder, the heat applied may interfere with the properties of the steel, whilst if the parts are brazed previous to their finish treatment, this treatment may possibly deteriorate the properties of the brazed joints. It is frequently possible to avoid trouble by raising the brazing temperatures beyond the embrittling range of the steel, usually about 1475 deg. Fah.

The lack of adherence of special steel joints brazed with silver solder is usually due to the formation of minute films of oxide. Addition of zinc chloride crystals to the fluxing mixtures prevents this formation and improves the results generally.

A very interesting feature of this process in its application to acid and rust-proof steels is the fact that the usefulness of the solder does not increase directly with the silver contents, but that best results are obtained with solders containing only about 10 to 15 per cent. of silver and about 3 per cent. of nickel.

British Railways as a National Asset.

No. II.

(*Continued from page 109, August 2nd.*)

SIX TRYING YEARS.

THE main purpose of our previous article was to show the extent of the business done by British railways and of the influence their prosperity had on the commerce of the country and on the personal life of the people. We showed the extent to which private capital was involved and how the sum of £1174 millions had been expended; what business it had produced, and at what cost. Those particulars mainly were based on the Railway Returns for 1933.

Coming now to consider this question in greater detail, and, in particular, to relate the business done during the year 1934, we have to be content with a consideration of the four main line companies, as we have their annual reports before us. As, however, 98 per cent. of the business done by the whole of the British railways was performed by those four companies, a consideration of their results will amply suffice for our purpose.

In submitting the figures we are not going to compare them alone with those of the preceding year of 1933, but also with the results of each earlier year, going back to and including 1929. As Sir Josiah Stamp said at the London, Midland and Scottish annual meeting on March 1st last, a one year comparison does not give a true reflection of the position. He therefore gave the contrast between 1934 and 1929, "which had become to be regarded as the nearest normal year." By examining the intervening years we are able to show the effect of the slump that set in in 1929, and which lasted until 1932, and through the greater part of 1933, after which period business began to improve.

It is not our intention to deal with each of the four main line companies separately; our purpose is to study the railway position generally. To consider each railway by itself might lead to unfavourable comparisons between two or more companies that would not be justified; those comparisons, moreover, could not be explained except at great length. We give, therefore, in each case the totals for the whole of the four companies. We also present the figures, in millions and in a graph, so that the course of business during the last six years can readily be grasped. It must here be added that, at this moment, we are dealing only with the results of what officially is termed "railway working," *i.e.*, there is nothing therein for such subsidiary business as canals, docks, steamboats, hotels, &c.

From Fig. 1 it will be seen that the gross receipts from railway working were £184·0 millions in 1929; that they fell to £171·0 millions in 1930, and to £157 millions in 1931. By 1932 they were down to £144 millions, which figure was 78·24 per cent. of the gross receipts for 1929. During 1933 they remained fairly stationary at £143·9 millions and then rose, reaching £149·7 millions in 1934, which was 81·31 per cent. of the 1929 figure.

Instead of giving the figures of both freight and passenger business we present only the freight receipts, partly because a brief calculation will then give the passenger gross receipts, but mainly because the freight business is the more important. The freight receipts are seen in the lower part of Fig. 1, from which it will be learnt that the £103·5 millions from freight traffic in 1929 became £96·5 millions in 1930 and £87·7 millions in 1931. By 1932 they had fallen to £78·9 millions, which figure was 76·50 per cent. of that of 1929. They fell a little more—to £78·5 millions—in 1933, and then increased to £83·0 millions in 1934, which result was 80·61 per cent. of those of 1929.

In considering the expenditure on railway working—the middle line of Fig. 1—it is important that it should be noted that the figures there shown are not those given in the expenditure column of the report. We have made that change for the simple reason that it does not appear to us fair to the officers concerned to charge them, as do the totals given in the accounts, with any sums placed to renewal or suspense funds; nor, for the same reason, should they escape from being shown to have spent certain sums withdrawn from such reserves. As a simple illustration, we may say that in 1932 the "maintenance of way and works account" on the London and North-Eastern had its total expenditure of £4,739,000 reduced to £4,659,000, by £80,000 transferred from renewal funds. On the other hand, that company, in the same year, was shown to have spent £6,558,000 on rolling stock, but £45,397 of that amount was for some reason transferred to renewal or suspense funds. To take a more recent illustration, the London, Midland and Scottish took £1,474,420 from renewals fund last year for the rolling stock account.

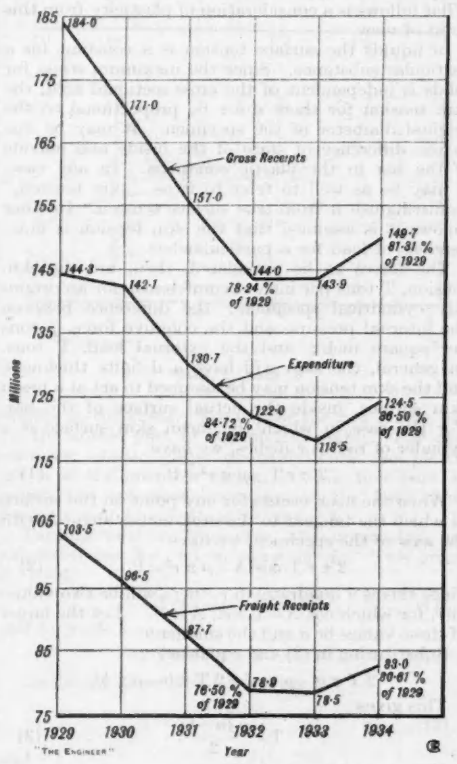


FIG. 1

This particular graph of the expenditure of the four companies for the six years in question is of particular interest in that it shows that the expenditure has not only been kept in alignment with the fall in the gross receipts, but that it has been more marked since 1930. In 1929 the expenditure was £144·3 millions, and was £142·1 millions in 1930. Then it was brought down to £130·7 millions in 1931, and to £122·0 millions in 1932. The latter figure was 84·72 per cent. of the expenditure of 1929. It was then reduced to £118·5 millions in 1933 and afterwards rose to £124·5 millions for 1934. Whilst the drop to 84·72 per cent. in 1932 was not sufficient to compensate for the fall to 78·24 per cent. in the gross receipts, there was less difference last year when the expenditure was 86·50 per cent. of the 1929 figure, and the gross receipts were 81·31 per cent. of those of 1929.

Table X of the annual reports gives the percentage of the total expenditure of railway working to the gross receipts. These show that the ratio of expenditure to receipts for the four main line companies during the six years 1929–34 inclusive was 78·68, 80·48, 81·08, 83·13, 81·67, and 80·86 respectively. In 1913 the ratio for the whole of the railways of the United Kingdom on £125 millions gross receipts was 63·17!

In Fig. 2 we give details of the four main items in the expenditure on railway working in the order in which they are presented in the annual reports. These are:—Maintenance of way and works; maintenance of rolling stock; locomotive running expenses; traffic expenses. It should be noted that the term "maintenance" includes renewals. The net receipts are also shown, by a thicker line, in this graph in order that their movement year by year may be seen reflected in the totals under the four heads of expenditure.

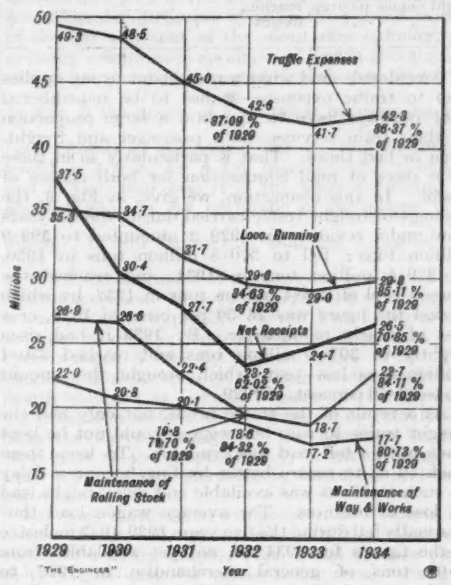


FIG. 2

The net receipts were, it will be observed, £37·5 millions in 1929, and fell to £30·4 millions in 1930, to £27·7 millions in 1931, and £23·2 millions in 1932, by which period they had decreased to 62·02 per cent. of the net receipts of 1929. They then commenced to rise and reached £24·7 millions in 1933 and £26·5 millions in 1934; the last was 70·85 per cent. of the 1929 net results.

Maintenance of way and works cost £22 millions in 1929, and in the three following years £20·8 millions, £20·1 millions and £18·6 millions respectively. The 1932 figure was 84·32 per cent. of that for 1929, but it was further reduced—to £17·2 millions—in 1933, and afterwards rose to £17·7 millions in 1934, which was 80·73 per cent. of the 1929 maintenance.

The maintenance of rolling stock cost £26·9 millions in 1929, and there was little change—£26·6 millions—in 1930. It then fell rapidly, reaching £22·4 millions in 1931, £19·3 millions in 1932, and £18·7 millions in 1933. The 1932 figure was 71·70 per cent. of that for 1929, and so a much greater reduction than that for the way and works. It rose, however, to £22·7 millions last year, and was thus 84·11 per cent. of the expenditure under this heading in 1929. Moreover, the 1934 figure was £4 millions higher than in 1933.

The increase of £4 millions for rolling stock in 1934 as against 1933 came mainly from £2,435,000 more on the L.M.S. and £1,000,000 more on the L.N.E.R. Those figures are often the adjustments for payments to and from revenue or suspense accounts. In this connection it may be observed that the "Review of the Company's Business" which accompanied the London and North-Eastern report for 1933, remarked: "As the trade on our system increased and developed in the latter part of the year, we made due provision for meeting it, and renewed 875 of our older wagons before the end of the year. In the belief that the welcome improvement in trade which we have experienced during the last six months is likely to be continued and very probably increased, and in view of the great development of our passenger traffic, considerable orders for the building of all classes of rolling stock have recently been placed." The corresponding Review for the year 1934 says on the same subject:

"As foreshadowed in the Review for last year, the revenue has been debited with increased expenditure upon rolling stock. For some years past the directors have reduced the expenditure on rolling stock as far as was possible, as, in view of the great decrease in traffic receipts since 1929, there was some doubt as to the extent of our ultimate requirements. The policy of the board has been to maintain in efficient

condition the requisite amount of rolling stock of all kinds for the traffic offering, but the considerable improvement of trade during the last eighteen months has altered the position and made the provision of new rolling stock imperative."

When the locomotive running expenses come to be considered—and what we are about to say applies also to traffic expenses—it has to be remembered that railways have to maintain a large proportion of their train services, both passenger and freight, even in bad times. That is particularly so in these later days of road competition for both classes of traffic. In this connection, we give, in Fig. 3, the tonnage of freight traffic carried during the six years now under review. In 1929 it amounted to 399·9 million tons; fell to 370·8 million tons in 1930, to 329·5 million tons in 1931, and reached the lowest level of 306·4 million tons in 1932, by which period the figure was 76·50 per cent. of 1929, or a loss of nearly one-quarter. By 1933 it had risen slightly to 307·5 million tons, and reached 330·1 million tons last year, which brought the amount up to 82·50 per cent. of 1929.

As a result of the traffic needs, not only had the freight trains to run, but wagons could not be kept back until a full load was available. To keep them back so as to secure better loading, meant a delay to such traffic as was available and delay might lead to loss of business. The average wagon load thus gradually fell during the five years 1929/1933 inclusive—the figures for 1934 are not yet available—from 3·08 tons of general merchandise in 1929 to 3·02 tons, 2·95 tons, 2·87 tons, and to 2·84 tons in 1933. The average number of wagons per train remained fairly constant. The figures therein for the same five years were: 34·49, 34·14, 34·12, 33·57, 34·07. Those figures were for both loaded and empty wagons. The average number of loaded wagons were 23·19, 22·34, 22·67, 22·33, 22·77. The lesser traffic on the line gave, however, the advantage of quicker transit, and the average net ton-miles per train engine hour were 929·41, 956·89, 968·29, 989·30, and 990·13. The greater locomotive power per engine would also contribute to that better result. We thus see that the 139·5 million freight-train miles of 1929 could only be reduced to 119·5 millions in 1932, or 85·27 per cent. of the 1929 figure, as compared with a drop to 76·50 per cent. in the freight tonnage, and that it was 125·6 million freight-train miles, or 89·71 per cent. of 1929, in 1934, as against 82·50 per cent. of the 1929 tonnage. The graph of the freight shunting miles comes under traffic expenses, which remain now to be noticed.

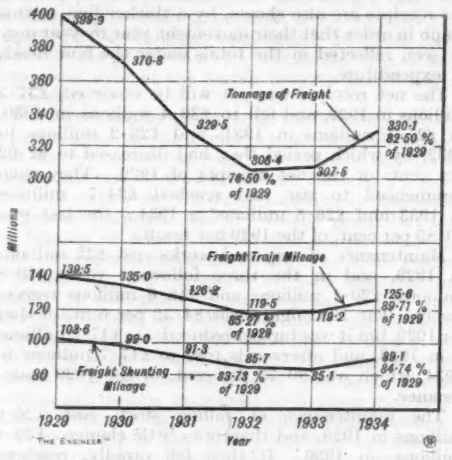


FIG. 3

Traffic expenses, as we noted in our previous article, cover the staff that controls the commercial side of railway working and the men at the passenger and goods stations, and those controlling the movements of trains, such as signalmen and guards—but not enginemen. Under this heading come the lighting, heating, &c., of stations, offices, &c.; the cleaning and illumination of carriages; the working of cranes, hoists, turntables, &c.; the shunting of carriages and wagons; the printing, stationery, and advertising. After what we have said as to the need for maintaining efficient passenger and freight train services, it will be recognised that many of these items of expenditure must be kept up even when traffic has fallen off. All that can be done is, as with the freight shunting mileage in Fig. 3, to secure some reduction. In the maintenance of way and works and of rolling stock great economies in procedure and in execution of the work have, as we shall show later, been possible. Such cannot be done in the traffic expenses, as the needs of traders and of the travelling public have to be considered. Thus by 1932 the £49·3 millions of traffic expenses in 1929, though the net receipts of 1932 were only 62·02 per cent. of those of 1929, could only be brought down to £42·6 millions—or 87·09 per cent. of 1929—and to £41·7 millions in 1933. Last year they had risen to £42·3 millions, or 86·37 per cent. of 1929, which is a much less increase than the rise in net receipts would have suggested.

An item which concerns both the locomotive running and the traffic expenses is the amount of engine power consumed in assisting other engines and in running light. The former concerns the running department, in that the power of the assisted locomotive is in question and both assisting and light running affect the traffic department—the former in that the loading of the train may be questioned and the latter as to the need for the engine to run light. The engine mileage consumed in assisting and in light running comes, in the annual reports, after train miles and shunting miles, under the one heading "other" miles (assisting, light, and departmental)—all of which are non-earning miles. The Ministry of Transport statistics require these, however, to be divided, and so they appear in the Railway Returns, in a separate table, and show the light running separately from the assisting mileage and whether the latter was required. Assisting engines often are put in front of a train in order to avoid the occupancy of the line and the greater time the journey would require if running as a light engine.

The assisting and light mileage and the divisions of the former are as shown in the table above. They are for all the railways and for 1929–1933 inclusive.

Assisting and Light Engine Mileage.

		1929.	1930.	1931.	1932.	1933.
"Other" miles	(Millions)	57¾	54¼	51	48	47¼
Assisting required, coaching	Per 100 train miles	1·10	0·98	0·86	0·82	0·88
,, ,, freight	,, ,,	4·03	3·24	2·56	2·31	2·37
Assisting not required, coaching	,, ,,	0·73	0·71	0·68	0·65	0·67
,, ,, freight	,, ,,	0·59	0·59	0·53	0·52	0·55
Light engine mileage, coaching	,, ,,	5·36	5·24	5·24	5·23	5·35
,, ,, freight	,, ,,	12·03	11·70	11·57	11·47	11·56

(To be continued.)

A Theory of the Plastic State in Metals.

By J. R. FULLARD, M. Eng. (Liverpool.)

IN the normal condition of any substance in the solid form, we should expect from the kinetic theory that there would be three forces acting—(1) a pressure due to the kinetic energy of the molecules; (2) a cohesive force produced by the mutual attraction of the molecules inside the substance; and (3) a surface tension due to the out of balance of the cohesive forces at the surface layers. The similarity of stress-strain diagrams for bars of different cross-sectional area, but of the same material, indicates that the surface tension effect is small in relation to the other two.

For metal bars of normal dimensions the formation of a neck at the end of tension and of a bulge during compression suggest surface tension phenomena. What follows is a consideration of plasticity from this point of view.

In liquids the surface tension is a constant for a particular substance. Since the maximum stress for solids is independent of the cross-sectional area, the skin tension for them must be proportional to the original diameter of the specimen. It may be due to the difference of state of the inside and outside of the bar in the plastic condition. In any case, it may be as well to refer to it as "skin tension," to distinguish it from true surface tension. In what follows it is assumed that the skin tension is independent of load for a particular bar.

The forces to be considered, then, are the skin tension, T tons per inch circumference, for an originally cylindrical specimen; the difference between the internal pressure and the cohesive force, p tons per square inch; and the external load, P tons. In general, the skin will have a definite thickness, and the skin tension may be assumed to act at a mean skin surface, inside the actual surface of the bar. For the case in which the mean skin surface is a cylinder of radius r inches, we have

$$2\pi r\,T - p\pi r^2 = P \quad . \quad . \quad . \quad . \quad (1)$$

When the neck occurs for any point on the surface at which the tangent to the neck makes angle A with the axis of the specimen, we have

$$2\pi r\,T\cos A - p\pi r^2 = P \quad . \quad . \quad . \quad (2)$$

Since this is a quadratic in r, there will be two values of r, for which $\cos A = 1$, *i.e.*, $A = 0°$. Let the larger of these values be a and the smaller b.

Substituting in (2) and equating,

$$2\,T\pi a - p\pi a^2 = 2\,T\pi b - p\pi b^2.$$

This gives

$$T = \frac{p\,(a+b)}{2} \quad . \quad . \quad . \quad . \quad (3)$$

Hence, substituting in (2),

$$P = p\pi a\,b \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Necking will commence, therefore, where $a = b = r$, that is, when $T = p\,r$.

Substituting in (1), we find that for maximum stress

$$T = \frac{P}{\pi r} \text{ and } p = \frac{P}{\pi r^2}.$$

Returning to equation (2), we have

$$\cos A = \frac{P + p\pi r^2}{2\,T\pi r}$$

Substituting in this from (3) and (4),

$$\cos A = \frac{r^2 + a\,b}{r\,(a+b)}$$

Hence,*

$$\cot A = \pm\frac{r^2 + a\,b}{\sqrt{(a^2 - r^2)\,(r^2 - b^2)}}$$

Put

$$r^2 = a^2\cos^2 X + b^2\sin^2 X = a^2\,(1 - k^2\sin^2 X) \quad . \quad . \quad . \quad (5)$$

where

$$k^2 = \frac{a^2 - b^2}{a^2}$$

Then

$$r\,d\,r = -k^2\,a^2\sin X\cos X\,d\,X.$$

Let x be the co-ordinate of points of radius r measured along the axis of the bar, from the point at which $r = a$, then $\cot A = \dfrac{d\,x}{d\,r}$.

Now

$$\frac{d\,x}{d\,X} = \frac{d\,x}{d\,r}\cdot\frac{d\,r}{d\,X} = \pm\left(r + \frac{a\,b}{r}\right).$$

Substituting for r from (5), we obtain for x an elliptic integral, the solution of which is

$$x = a\,E\,(k, X) + b\,F\,(k, X) \quad . \quad . \quad . \quad . \quad (6)$$

$$r = a\,\Delta\,(k, X) = a\sqrt{1 - k^2\sin^2 X} \quad . \quad (7)$$

Values of the elliptic functions, E (k, X) and F (k, X) may be obtained from tables.† Plotting equations (6) and (7) for various values of b, keeping a constant, we obtain the family of curves shown in Fig. 1. According to the theory, these represent stages in the necking of the bar, an initial mean skin surface diameter of 1in. being assumed. These shapes are in good agreement with those of tensile test specimens which have passed through a plastic stage to fracture. The same curves‡ may be drawn by plotting the loci of the foci of ellipses of different excentricities when rolling on a straight line. The outer surface follows the mean skin line as it falls in at the neck. Material from the original cylinder is displaced outwards along the axis and adds to the length of the specimen. At the same time this outward flow tends to prevent the formation of other necks. On some fractured tensile specimens traces of a further slight depression may be found, and Unwin § points out that in rare cases two local contractions form at different parts of the length.

If we assume constant density, the excess material which goes to increase the length of the bar is the difference in volume between the cylinder of cycle length and the cycle volume, or volume of the neck, V. The increase in length is therefore given by

$$\frac{2\pi a^2\left\{a\,E\left(\frac{k,\pi}{2}\right) + b\,F\left(\frac{k,\pi}{2}\right)\right\} - V}{\pi a^2} = z \text{ (say)} \quad (8)$$

V is the volume of the solid of revolution of the neck curve, given by equations (6) and (7). It has been found by the theorem of Guildinus from the curves in Fig. 1 for various values of b. The resulting values of z from equation (8) have been plotted against b and are shown in Fig. 2. Combining equations (3) and (4), we find

$$P = \frac{2\pi a\,b\,T}{a+b} \quad . \quad . \quad . \quad . \quad . \quad (9)$$

If T is assumed constant, and the load when the mean skin surface is cylindrical is P_m, we have

$$T = \frac{P}{\pi a}.$$

Substituting in (9), we get

$$\frac{P}{P_m} = \frac{2\,b}{a+b} \quad . \quad . \quad . \quad . \quad . \quad (10)$$

* See Lamb, "Statics," page 285.

† Mathematical Tables, Dale, Arnold.

‡ See Lamb, "Statics," page 283.

§ See Unwin, "Testing of Materials," page 72.

Using the values of b and z from the graph, Fig. 2, $\frac{P}{P_m}$ has been plotted against z, and is shown in Fig. 3. This corresponds to the end of the ordinary stress-strain graph for ductile materials in tension. Fracture occurs for practical specimens before the maximum value of z is reached. It may be remarked that the expression $\frac{P}{P_m}$ has no units, and so is independent of the original diameter of the bar.

The distribution of the elongation due to necking

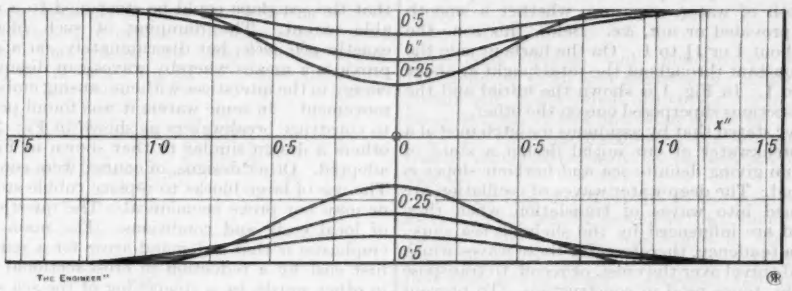
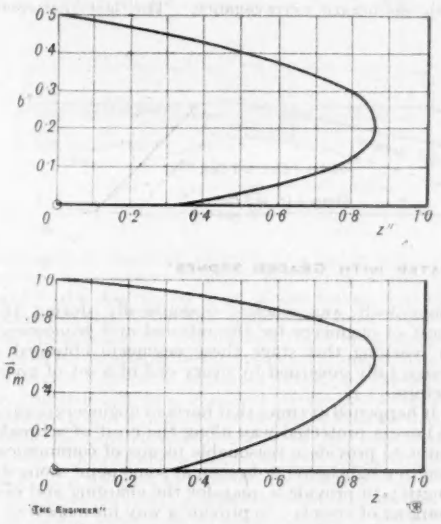


FIG. 1

along the bar is obtained by assuming that if the bar is originally marked off in definite lengths, say, inches, then the volume of metal between adjacent inch marks is constant. In Fig. 4 graphs have been drawn, obtained from those in Fig. 1, of extension per inch against distance from fracture, for various values of $\frac{b}{a}$. In comparing these with graphs obtained from tests, it must be remembered that they do not include the extensions produced up to the point of maximum load, but only those due to the necking



FIGS. 2 AND 3

itself. Fracture occurs by shear through the skin, due to the combined skin and hoop tensions.

The first part of the plastic tension stress-strain graph is found by assuming that the mean skin line is originally at the yield point of the type shown in Fig. 1. As the load rises, the value of b must increase, a remaining constant. In rising, the skin line forces away the material between it and the outer surface, which retains the cylindrical form.

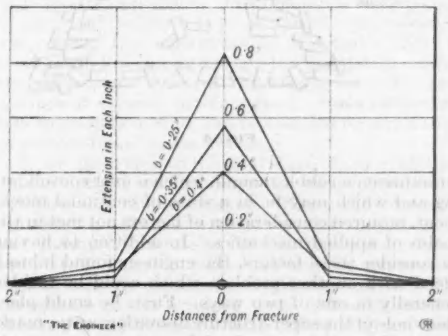
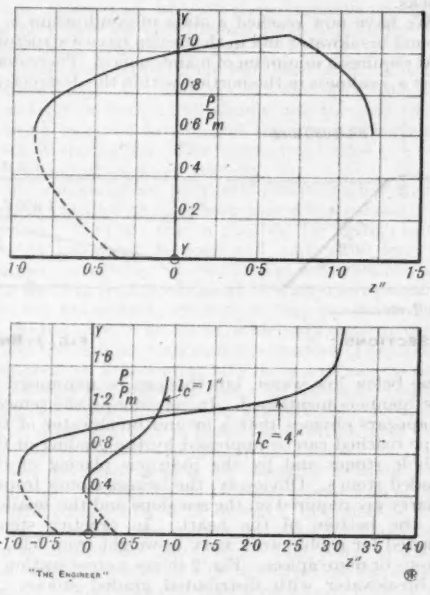


FIG. 4

This material adds to the length of the bar. The cycle length is maintained by the shrinkage of the outer surface. The change in length is most conveniently measured from the length when the mean skin surface is cylindrical of radius a. From this point to a point where $r=b$ the reduction in length is equal to the increase in length given in equation (8), that is, to z in Fig. 2. It is apparent that, since material is being forced out of the skin as the load increases, all the possible cycles within the length of the specimen will tend to be formed.

The graphs in Figs. 2 and 3 will apply to the first part of tension, if the values of z are taken as negative. The skin cylinder to which the graphs, thus modified, apply is of cycle length, *i.e.*, π inches long for 1in. diameter.

Fig. 5 shows a typical complete graph for tension, according to the theory, allowing for a length of 8in. in the bar to a length of π inches for the single cycle in necking. By comparison with actual test results, it appears that the mean skin line rises beyond the straight line form, giving the part of the graph beyond Y Y in Fig. 5 before necking commences. This effect is present with mild steel, but is more pronounced for copper. The yield point for any substance for which the elastic stress-strain graph does not cut that for the plastic state should occur in the neighbourhood of the minimum value of z, if the elastic graph tends to rise above this point. This



FIGS. 5 AND 6

applies to the steels. For copper the two graphs cut on the stable part of the plastic graph. For cast iron the elastic graph probably cuts the plastic graph in the unstable region, *i.e.*, the first part, in which the extension decreases as the load rises. So there is no plastic state for cast iron.

Turning next to the case of compression, we substitute $\cos A = +1$ in equation (2). This gives, for $r=a$,

$$-2\,T\,\pi\,a+p\,\pi\,a^2=-P \quad . \quad . \quad . \quad (11)$$

and for $r=b$,

$$-2\,T\,\pi\,b+p\,\pi\,b^2=-P \quad . \quad . \quad . \quad (12)$$

Combining these equations gives

$$T=+\frac{p\,(a+b)}{2} \quad . \quad . \quad . \quad . \quad . \quad (13)$$

and

$$P=+p\,\pi\,a\,b \quad . \quad . \quad . \quad . \quad (14)$$

In the original equation (2) therefore, if P becomes negative, that is to say, compressive, then p becomes negative, *i.e.*, the internal cohesion becomes more than the internal pressure. The skin tension T becomes negative, *i.e.*, becomes a skin pressure.

From equation (2) we have

$$\cos A=\frac{P+p\,\pi\,r^2}{2\,T\,\pi\,r}.$$

Substituting in this from (13) and (14),

$$\cos A=\frac{r^2+a\,b}{r\,(a+b)}$$

This gives the same formula for x as was previously found in tension, equations (6) and (7). The cyclic curves of Fig. 1, therefore, also represent compression, giving the shapes of the mean skin line. When the substance enters the plastic state, from the elastic condition, the outer surface is cylindrical, and b is less than a for the mean skin line. As the load increases the mean skin line rises, pushing the material between it and the outer surface outwards, forming the bulge. Since the cycle volume is increasing, this will result in a decrease in length. The amount of compression may be determined by considering the earlier compressions as extensions from the cylindrical mean skin surface condition. The values obtained will be identical with those for tension, so that the graphs Figs. 2 and 3 may be applied to this part of compression. The behaviour of the specimen in compression will depend on the original length. The length of the mean skin cylinder is $\pi\,d=2\,\pi\,r$. This gives a length of the specimen at the beginning of the plastic state in compression $=2\,\pi\,r+2\,r\times0{\cdot}87=2\,r\times4{\cdot}01$. Unless there is a considerable difference between the outer diameter of the bar and that of the mean skin cylinder, an ordinary compression specimen of length about equal to the diameter will be a good deal shorter than this.

In Fig. 6 the graph of $\frac{P}{P_m}$ against compression has been plotted for two cases. In one case the initial length is 4·01in. for a 1in. diameter skin cylinder, and in the other case it is 1in. when $b=0{\cdot}2$in., or about 0·95in. at the beginning of the plastic condition. It will be noticed that the value of $\frac{P}{P_m}$ at the commencement of plasticity is smaller for the shorter specimen. In both cases the end of the graph is a more or less hyperbolic curve. This is due to the volume inside the skin line being less than the cycle volume V for the higher values of b. The length of the specimen under these conditions is the length occupied by volume V inside the corresponding mean skin surface, and is obtained by calculation from the curves in Fig. 1. The condition in the early part of the graph, Fig. 6, in which compression falls as load increases is unstable, and will not occur.

For both tension and compression the "natural" elastic limits will correspond with the minimum values of z in the graphs, Figs. 5 and 6, since plasticity cannot exist for values below these. Fatigue fracture may be explained by assuming that material passes through the skin, a small amount at each reversal, until the skin line reaches the outside of the specimen when fracture will occur. The values of a and b for the skin line remain constant. The amount passing through at each reversal will increase with the maximum load. It will be noticed that, both in tension and compression, the tendency with increasing load is to force material inside the skin line. Fatigue fracture will not occur below the "natural" elastic limits because the material cannot exist in the plastic state below these points.

Creep, where it occurs, may also be supposed to be due to a slow passage of material from the outside to the inside of the skin line, similar to that producing fatigue effects, but taking place under a steady load.

It will be seen that the theory gives results which agree with the observed facts, both geometrical and mechanical. In determining the necessary cycle volumes, the figures were drawn out to a scale of eight times full size and a planimeter was used. The work would have been much simplified if tables of $\int(1-k^2\,\sin^2 X)^{\frac{3}{2}}\,dX$ had been available, for

$$V=\int\pi\,y^2\,d\,x=\pi\,a^2\int(1-k^2\sin^2 X)^{\frac{3}{2}}\,dX$$
$$+\pi\,a^2\,b\,E\,(k, X)$$

In applying the graphs, Figs. 1 to 6, to practical cases, the extensions and compressions z must be multiplied by $\frac{a^2}{R^2}$, where R is the outer radius of the specimen, since the denominator in equation (8) should be $\pi\,R^2$ in these cases. The actual value of this ratio will depend on the material under test.

A NOTE in the *British Russian Gazette and Trade Outlook* states that Moscow is to be entirely reconstructed. The general historical interest of the city is to be preserved as far as is possible, but the city is to be replanned and organised into domestic and housing districts, business, and industrial quarters, &c. The main thoroughfare is to be along the banks of the Moscow River. A system of streets radiating out from the centre and forming boulevards and of cross streets, will be provided for. The population of the city is to be limited to 5,000,000. New canals are to be built and a vast amount of work is to be done in providing new water systems, streets, factory kitchens and public dining rooms, hotels, mechanised bakeries, and refrigerating plants, &c.

THE by-pass road at Wandsworth which the London County Council, with a grant from the Road Fund, is making between Putney Bridge-road and York-road, is near the site of the commencement of the first public railway—the Surrey Iron Railway, sanctioned in 1801. It began in what was then known as Ram Field by a dock or basin for barges in Wandsworth Creek. This dock is now the property of the Wandsworth, Wimbledon and Epsom District Gas Company, and is still known as the Railway Wharf. In THE ENGINEER of January 5th, 1900, appeared some illustrations of the wharf at that time. The inner lock gates and a drawbridge then illustrated are still there, but the outer lock gates, leading into the Thames, have been renewed, and the wooden crane has disappeared.

Evolution of the Breakwater.

By W. N. ELGOOD, University of Bristol.

IT is generally recognised that harbour engineering, regarded as a science, is far from ideal. Unlike, say, physics, it does not offer those lines of inquiry to the investigator that are truly scientific. Its laws rest on observation and seldom on experiment, and it cannot infer theories by the impeccable method of strict mathematical analysis. Compared with other sciences, it is not perfect; it knows little of laboratory work, little of inductive reasoning, and, in consequence, little of the establishment of exact theories. In the observation of behaviour contact is made with those forces of Nature which are difficult to reproduce in scale model form in the laboratory. Experimental work must be undertaken with full-scale models that are actual structures performing their legitimate functions. The magnitude of these structures prohibit the immediate changes in design necessary for experimental investigatory work. Actual experiments must perforce extend over many years and little in the modification of apparatus can be accomplished. Like the astronomer, the harbour engineer cannot handle his materials, nor can he, at will, reproduce a set of circumstances. It is not surprising, therefore, that harbour structures have not from time to time shown sudden improvements or radical changes in design. There has appeared, with the majority of structures, a gradual development which is, in actuality, an evolution. We have the evolution of the converging jetties from the parallel jetties of the early North Sea ports and the evolution of the upright wall breakwater from the dumped rubble mound of early man, to quote but two. Let us examine here the several stages of this second evolution.

Undoubtedly early man, in attempting to improve a partially protected natural harbour, constructed a mound breakwater by the dumping of rubble stones. It is found that if the structure be assiduously maintained a state of equilibrium can be approached in the course of time. A change in the initial shape of the cross section takes place. On the sea side within the destructive zone of the waves the slope becomes at least 5 to 1 and perhaps as flat as 10 to 1, depending upon depth of water, exposure, whether a smooth apron is provided or not, &c. Below this zone the slope is about 1 or $1\frac{1}{4}$ to 1. On the harbour side the slope is constant throughout the total height at about 1 or $1\frac{1}{4}$ to 1. In Fig. 1 is shown the initial and the modified sections superposed one on the other.

We have stated that by assiduous maintenance of a mound breakwater of our initial design a state of equilibrium giving definite sea and harbour slopes is approached. The deep-water waves of oscillation are transformed into waves of translation when they reach and are influenced by the shelving sea slope. There is a tendency, therefore, for these waves which break and travel over the crest, or recoil, to transpose the rubble stones used in construction. To prevent this transposing the sea slope can be pitched in cement mortar to obtain a smooth apron, as was done on the Plymouth breakwater. In and below that portion of the destructive wave zone below low water, where such pitching cannot be undertaken, large stones or cement blocks weighing up to 20 tons or more apiece can be deposited to prevent further destruction, and to afford a means whereby waves can dissipate a portion of their energy in the interstices. Alternately, in place of smooth pitching above low water, the whole of the sea slope can be protected by large blocks.

We have now reached a state of equilibrium in a mound breakwater and in the design have a structure that requires a minimum of maintenance. There does exist a weakness in the portion within the destructive zone below low water, but this can be minimised in the manners mentioned. In considering the remedy it appears obvious that a mound breakwater of the type reached can be improved by the grading of the rubble stones and by the judicious placing of the graded stones. Obviously, the largest stones from a quarry are required on the sea slope and the smallest at the bottom of the heart. In practice stones blasted for rubble work vary in weight from 5 lb. to 2 tons or more apiece. Fig. 2 shows a cross section of a breakwater with distributed graded stones. A number of such structures have been constructed, but their capital costs have been high. It is problematical if the saving effected in the annual recurring costs of maintenance balance the first cost increase.

Further consideration shows that an obvious improvement of the design reached is to be found in the prevention of the deep water waves of oscillation becoming transformed into waves of translation. This can be accomplished by the steepening of the sea slopes towards a vertical face. In the following description of the succeeding stages of the evolution under discussion, it will be seen that there was an ever-present tendency for the required steepening to be reached. In theory a wave of oscillation will not break on a vertical face, nor will it subject such a face to impact effects. Actually, deep sea waves are not true waves of oscillation, and when they come into contact with a vertical face a certain amount of impact may be experienced. If cracks and suitable openings are present in the face, there may be water hammer or compressed air effects. In general, however, the theory that deep sea waves are true waves of oscillations was accepted, and the tendency in the development of design was to get away from the slow shelving slope in the destructive wave zone of the equilibrium rubble mound.

It will be realised that the construction of a rubble mound breakwater of an equilibrium section, even if the rubble be ungraded—that is, if the rubble be dumped *pêle mêle* as received from the quarry—is an expensive structure. The cost is apt to prove exorbitant when compared with the total cost of construction of the harbour of which it forms a unit. Again, it will be realised that the time required for construction is comparatively great, and may extend over many years. It is possible that the time element may rule such a structure out of consideration, as in a location where dumping from barges can only be undertaken during the slack periods of the tide. Under certain conditions, however, the dumped mound is the quickest structure to construct, as was found in the Rangoon River, where only 40 minutes of dumping could be undertaken during each tide cycle. It is not surprising, however, that a demand was born for a rigorous curtailment of capital cost without a subsequent increase of recurring annual costs. The obvious direction in which to seek a solution of the problem of effecting an economy was towards a drastic reduction in the volume of the material used, or, in other words, in the cross-sectional area. This search led to the replacement of the small rubble stones of the sea slope by blocks of such weight that they could not be transposed during heavy seas. The use of these heavy blocks meant that the sea slope could be steepened to a considerable extent. The dumping of such blocks, not exactly *pêle mêle*, but discriminately, on a sea slope provides a means whereby waves can dissipate their energy in the interstices without causing embarrassing movement. In some waters it was found practicable to construct breakwaters as shown in Fig. 3, and in others a design similar to that shown in Fig. 4 was adopted. Other designs, of course, were constructed. The use of large blocks to replace rubble stones may or may not prove economical. The question is one of local costs and conditions. The main point to emphasise is that a demand arose for a reduction in first cost by a reduction in cross-sectional area, or, in other words, by a steepening of the sea slope. It is interesting to note that in the construction of Port Said Harbour at the Mediterranean end of the Suez Canal, it was found that a breakwater consisting wholly of concrete blocks was the most economical for a proportion of the time of work in progress. At other periods two types of combinations of rubble stones and concrete blocks were the more economical.

Up to this point the evolution in the design of the breakwater followed along lines that can be visualised without difficulty. The advancement to the last stage discussed was due more to governing conditions than to reasoning by engineers, and necessarily involved much expenditure of time, money, and patience that may appear to be extravagant. Our opening paragraph shows that actually there was no such deliberate extravagance. The last discussed stage itself was reached undoubtedly during the quest of engineers for the rational and economical. In reaching this stage these engineers obtained a design fully governed by every one of a set of given factors.

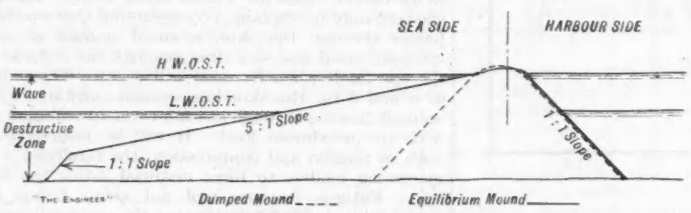


FIG. 1—INITIAL AND MODIFIED MOUND SECTIONS

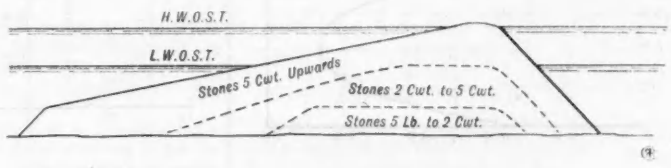


FIG. 2—BREAKWATER WITH GRADED STONES

The stones in such a mound heap up with side slopes determined by the angle of repose of the material. The breaking of the waves together with any recoil there may be cause a displacement of these stones and a flattening of the slope on the sea side, and possibly a similar modification, but to a smaller extent, to the harbour slope. The displacement on the sea slope takes place mainly inside the destructive zone of the waves; that is, between high water and low water to, perhaps, 20ft. or more below. In this respect the experience of the engineers responsible for the construction of the isolated breakwater at the entrance to Plymouth Harbour is worthy of reference here. A design submitted by Mr. Rennie with a sea slope of 3 to 1, which is flatter than the natural slope, was accepted in 1811. In the following year the work of construction was commenced and nothing untoward

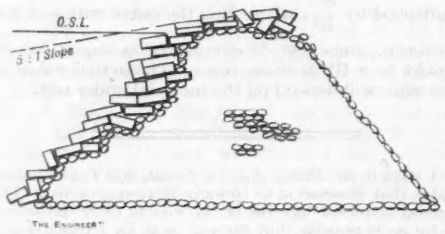


FIG. 3

happened until 1817, when, during a south-westerly gale, stones dumped between low and high-water marks and weighing up to 5 tons apiece were displaced from the sea to the harbour side. It was not deemed necessary then to modify the design. Repairs were duly executed and the work of dumping proceeded as before. In 1824, however, after two million tons of stones had been deposited, a length of 2400ft. of the breakwater was flattened during another south-westerly gale. This experience showed that a modification in design was advisable. This modification was effected in 1825 by softening the sea slope to 5 to 1, and by paving it with granite blocks set in cement mortar from low water upwards. An almost stable structure was then obtained despite the exposure of the south-west portion normally to the full force of the Atlantic waves during the heaviest gales.

Mound breakwaters, as dumped by early man, demand constant upkeep and renewal of the stones.

It happened at times that harbour engineers desired to have a protected way along the crest of a breakwater to provide a reasonable means of communication to a lighthouse or beacon at some point along its length; to provide a quay for the charging and discharging of vessels; to provide a way for inspectors; or to make provision for some other ancillary function. The construction of a breakwater to meet any of these requirements called for a new consideration in design. A protected way demanded the addition of a superstructure, preferably constructed of machined or tooled masonry, or mass concrete blocks, set in cement mortar. The obvious design, if economy were desired, called for vertical faces on the sea and harbour sides. The design of an exposed super-

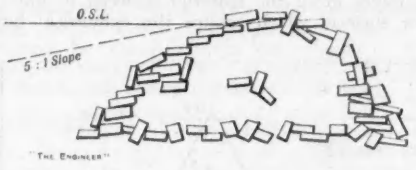


FIG. 4

structure on a rubble mound, which is ever consolidating and which may be in a state of continual movement, required consideration of factors not met in the realm of applied mechanics. In addition to having to consider these factors, the engineer found himself faced with another problem which could be tackled generally in one of two ways. First, he could place the whole of the superstructure above low water mark, when all the masonry work of the superstructure could be consolidated by being laid in cement mortar. In this design there would be little liability of the foundation being so undermined as to be washed away or destroyed, providing full attention were given to the design. The harmful effects of settlement could be lessened by building the structure in sections and leaving suitable joints. Secondly, he could place the foundation of the superstructure below low water level, when only that portion above low water could be consolidated in cement mortar, and that portion below that level consolidated as far as practicable

by a high degree of workmanship in making and completing the dry masonry joints. In this case, the foundation of the superstructure may be undermined, but practice has shown that good workmanship can almost eliminate probability. Settlement can be looked after as in the first method. Figs. 5 and 6 show the two general types of rubble mounds with superstructures.

The necessity of adding superstructures advanced the development in the design of breakwaters. The use of a superstructure with a vertical face lessens the volume of material required for construction and gives a decided reduction in the cross-sectional area. It was only necessary to show that a saving in costs could be effected to obtain a definite step forward in design. The greater the height of the superstructure, or, in other words, the lower the depth

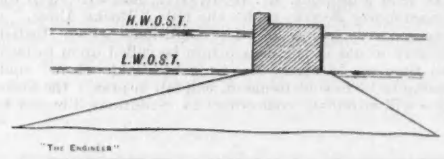


FIG. 5

of the foundation, the greater the saving of materials. The amount of the first cost depends mainly on local conditions. In the majority of cases it is found that there is a height of superstructure which is a limit in economical design. A mound breakwater with a superstructure of a height greater than this limit is economical; if with a superstructure of a height less than this limit it is not economical. The limiting height is determined by local conditions—that is, by the local prices of labour and materials. If reliable workmanship is obtained the costs of maintenance of a mixed breakwater of rubble mound and masonry superstructure are apt to be less than those of a mound breakwater. It is seen that local conditions may be such that for economy in one location it is

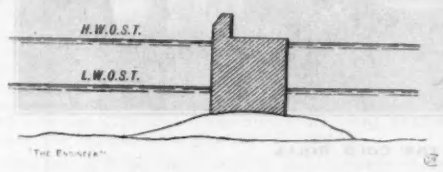


FIG. 6

advisable to found the superstructure at or above low water, in a second location below low water, but within the destructive zone of the waves, and in a third location below the destructive zone. At first the designs for the second and third locations presented for solution difficult problems in maintenance; they were a source of continual worry. As experience in construction was obtained, these problems disappeared, and a masonry structure of reliable design could be constructed in water of any practicable depth. The physical advantages of the superstructure were soon realised, for, outside its function of providing a protected way, it afforded certain protection to the rubble mound as, in some designs, it tended to prevent waves from washing over the top into the harbour, and thus transposing rubble stone. The design of a superstructure is therefore set with difficulty. While the energy of a wave is dissipated gradually on a rubble mound breakwater, or, in other words, while the force exerted by a wave is gradually lessened, the wave being broken, and a portion passing over the crest into the harbour, a superstructure offers opposition to that portion of a wave which has been transformed into a wave of translation. In certain circumstances it may have to oppose the whole force of the breaking wave by presenting a solid face of opposition. Practice tends to show that in the most suitable type of mixed breakwater in deep water the superstructure is founded 20ft. or more below low water to locate the foundation outside the destructive zone of the waves, and the base consists of a simple rubble mound. Such a structure, like the rubble mound, can be founded on any nature of bottom found in sea waters.

It is a short step to the final stage of our evolution. In the upright wall we have the mixed breakwater without the rubble mound. From the foregoing remarks its advantages can be readily realised. It has, however, limitations in use, for it requires an adequate foundation and it can only be constructed economically in moderate depths of water. The elimination of the breaking wave of translation has obtained a condition of affairs that is of great value to the harbour engineer. The reduction of the cross-sectional area to the bare minimum has resulted in an ideal being reached. As in other breakwaters, the economics of its use are based on local conditions.

In tracing out the several stages in the evolution of the breakwater, it is possible that enough emphasis has not been placed on the part played by harbour engineers. Evolution of a design is not possible unless there are engineers ready to profit by experience and ever on the alert to realise tendencies due to natural and other causes. The harbour engineer has always been forced to play a waiting part. His labours of observation and improvement never cease. The improvements in the design of breakwaters are solely due to engineers ready to benefit by experience and ready to scrap old ideas for new.

It has only been possible here to give a general outline of the evolution considered. It is outside the scope of this article to discuss in detail the many different types of design, and such items as the most efficient profile for the sea face of an upright wall or a superstructure.

Metals Used in Yacht Construction.

(By a Correspondent.)

METALS (ferrous and non-ferrous) are being adopted more and more in the construction of yachts and boats which are comprised in the large pleasure fleets of this and other countries.

In the following paragraphs this progress is discussed more particularly in its relation to sailing yachts.

It is no new development to use steel and other metals for the plating as well as the framing of sailing yachts. The practice was begun in this country. The "Mosquito," of 50 tons, built in 1848, was the first iron sailing yacht. Although the iron (steel) sailing yacht never had a great vogue in British waters, the steam yacht, on the other hand, has rarely been built of anything else, for the few steam pleasure craft constructed of wood were hardly more than steam launches. However, another and a larger iron sailing yacht was built many years later (1883). This was, or rather is, the "Wendur," of 143 tons, for she is still on Lloyd's Register of Yachts, so well have material and workmanship withstood the tests of time. But perhaps the most famous British racing yacht of iron (steel) construction was the "Thistle," which in 1887 carried the challenge for the America's Cup. A few years later she passed into the possession of the Kaiser, and her life as a yacht was rather more than thirty years altogether.

Then other metals have also been used. The first "Shamrock" to challenge for the America's Cup was built of bronze and aluminium, the underwater plating being of bronze and the upper plating and deck of aluminium. The bronze was buffed to a high polish to reduce water friction.

It is unnecessary to mention other earlier British sailing yachts that have been plated in steel and other metals. They are few in number, for British racing yachts exceeding 35 tons and under 200 tons are almost invariably of composite construction, *i.e.*, the framing is of steel sheathed with wood planking. On the other hand, cruising sailing yachts as large as 50 tons are to be found, which are constructed of wood throughout, although the practice of composite construction is becoming now more and more general in cruisers exceeding 35 tons. In the case of sailing yachts exceeding 200 tons, whether they be racing or cruising craft, it is practically certain that they will be built mainly of steel in the future.

The principal reason for adopting a metal construction throughout is to ensure lightness of hull weight consistently with strength, but there is little to be gained in this respect until the tonnage of the yacht approaches 200. From this point upwards, not only is a yacht of steel construction throughout lighter in displacement than a composite craft of the same measured tonnage, but it is also possible to place the former's centre of gravity at a rather lower depth. Lightening the displacement ensures that the hull will not only be more easily driven, but will also gather way more quickly in response to slight increases in the strength of the wind. And lowering the centre of gravity enables the craft to stand up more stiffly to her canvas or, alternatively, to carry more sail. A composite yacht possesses the same advantages over one of all-wood construction, but not to the same extent as one of metal throughout.

It might perhaps appear advantageous to employ aluminium for the whole of the upper portion of the hull, but unfortunately this material has been found very perishable when used in yachts, although some of the later aluminium alloys have withstood the sea atmosphere much more satisfactorily.

The frames of composite yachts are generally of rolled angle section or built up from rolled material, the steel most commonly employed for this purpose being the well-established material of 26 to 30 tons tensile strength. But alloy steels of much higher strength than this have been adopted from time to time during the last twenty years or so, and they are being used more and more.

More or less smith's work is to be found in sailing yachts, especially in the fittings of masts and spars, and in some of the deck fittings. These forgings are usually galvanised.

When proper care is taken to preserve steel, it is, of course, much more durable than wood. For example, a composite yacht built of the best materials, and under the full conditions laid down by Lloyds', could receive a classification number (20) in the register, and a yacht of steel construction (plating as well as framing), also built under the full requirements, could receive the number 100. The ratio of these two figures (100 to 20) may be regarded as, in effect, a relative measure of the durability or life of the two types of construction. But it should be observed that there would be practically no difference in the strength of these two vessels since strength must be adequate to withstand sea and weather, &c. But British waters and the atmospheric conditions round our coast do not put the carefully selected and well-seasoned woods of shipbuilding to a severe test. Pests such as the teredo beetle (the ship worm) and the white ant, which play havoc with unprotected wood in tropical and sub-tropical latitudes, are negligible in our waters. Nor does timber in this country have to endure long periods of extremely hot sun and very dry atmosphere.

In the United States it has been the practice for many years to build the larger racing yachts of metal (bronze, steel, &c.) throughout, and, in fact, there is a very pronounced tendency in that country to employ metal more generally in yacht construction.

On the other hand, our climate's more frequent changes from warm to cold and *vice versâ* are a cause of correspondingly frequent oscillations of temperature within a vessel plated with steel or other metal. For this reason some kind of artificial heating appliance is absolutely necessary in a yacht of metal construction throughout, whereas a wood-planked vessel might go through a whole summer without actually requiring artificial heat. Should the temperature on the inside of the vessel's skin fall below the dew point, there is generally considerable "sweating" and trickling of water down into the bilges and keel. To diminish this inconvenience of metal-plated craft, the method which is perhaps most commonly employed is that of the non-conducting layer of cork powder dusted over the inside of the plating and then covered with a coating of paint to keep it in place.

Another advantage obtained by adopting metal plating for a yacht's skin is to be seen in the space gained within the vessel. Taking the case of two yachts of, say, 15ft. maximum external width, one built of steel framing and plating throughout, and the other with timbers (ribs of wood) and wood planking, then the clear internal width of the former would be about 1ft. greater than that of the latter—an appreciable gain in living accommodation. If the second yacht were of composite construction, its internal width would be about 6in. less than that of the all-metal vessel, and so on in approximate proportion for craft of other extreme width (maximum beam).

A yacht of wood framing and planking may become rather noisy internally. Changes in the humidity of the atmosphere and the usual variations from damp to dry, and *vice versâ*, may cause a good deal of creaking when the craft is moving among waves, which, of course, cause the whole structure to work somewhat. This annoyance is not so noticeable in composite yachts, and it is entirely eliminated by the adoption of all-metal construction.

On the other hand, metal-plated yachts may sound a strong drumming note in heavy weather, but the seams of the plating generally remain tight, whereas it is by no means an uncommon experience to find the seams of wood yachts leaking when the hull is being severely pounded among waves.

There is a great deal of non-ferrous metal in every sailing yacht. For example, there is the heavy lead keel, which may account for anything between one-third and one-half of the whole displacement of the vessel, and the keel is secured to the framing by means of many long bronze bolts. Then, in the case of a composite craft, the planking is fastened to the framing with copper bolts, and sometimes yellow metal is used for this purpose.

The sheaves in the rigging blocks (*i.e.*, the pulleys) and also the pins on which they turn, are of bronze in the higher quality of rigging blocks.

Thin cold rolled copper sheeting is still employed to sheath the underwater body of wood-planked yachts, although this practice is not now adopted to anything like the extent that was usual in years gone by. Sea growths and marine life generally do not attach themselves so precipitately to sheathing as to a wood surface, nor is the former so vulnerable to their attack as wood, and it can be vigorously scrubbed and polished to remove such growths as have attached themselves.

It is in place here to mention that stainless steel is rapidly growing in favour for fittings on yachts' decks, which have been made hitherto of bronze and brass or in the less highly finished craft of galvanised steel forgings or stampings.

The time spent every morning on the polishing of a yacht's brasswork is not inconsiderable, and by adopting stainless steel most of this labour is eliminated. Moreover, brasswork necessitates the use of polishing paste or fluid, but even the most careful

yacht-hand may at times leave dark unsightly smears on the deck and woodwork near the fitting he has been polishing, and stainless steel obviates all that.

Wire rope is employed throughout for the rigging of almost all yachts. Very much has been done in recent years to increase the dependability of steel wire rope, and this advance has been very beneficial to the yachtsman, for it has had incidentally the effect of increasing the ratio of breaking strength to weight per foot run, thus ensuring strong, yet light, rigging.

For the most part, the wire rope used aboard yachts is of the plough steel quality, but efforts are now being made to produce fully trustworthy ropes of stainless or rustless steel.

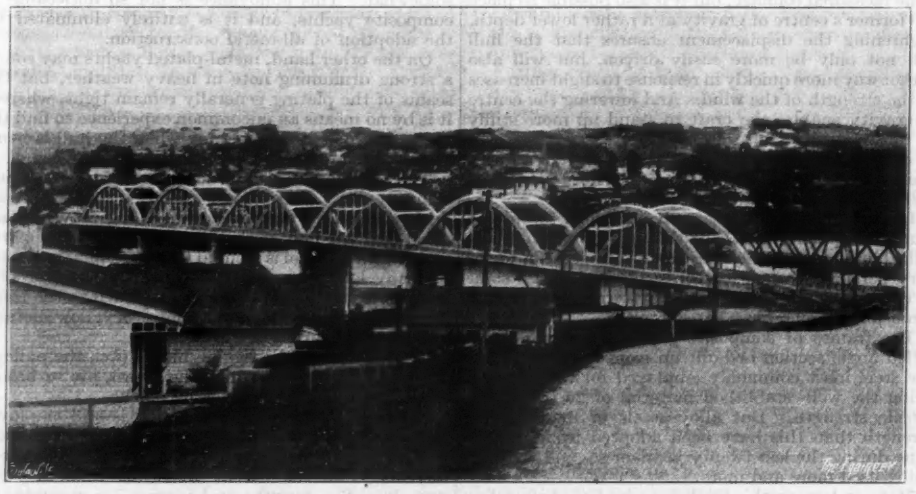
This marks a considerable advance from the yachtsman's standpoint, for apart altogether from the fact that the stainless steel will have a rather more pleasing appearance than galvanised wire, which soon becomes dark and discoloured, it has to be borne in mind that the practice of protecting steel from corrosion by galvanising it has the inherent defect of weakening the material.

The reduction of strength is not of high percentage where the material galvanised is relatively thick, but in the case of the comparatively fine wire used for the strands of even the largest ropes, the weakening is a matter for serious consideration.

New Bridge at Balclutha (Otago, New Zealand).

THE new highway bridge constructed at Balclutha at a total cost of more than £40,870, is in many ways the most interesting road bridge that has been built in New Zealand. This structure, which is illustrated by an accompanying engraving, has an overall length of more than 800ft. and a width of 38ft. 7in. It provides for a roadway 22ft. in width between kerbs and a footway on either side averaging 4ft. in width. Normally the roadway of a bridge of this length would be 20ft. wide, but in view of the importance of the local stock traffic the Main Highways Board decided to increase the width to 22ft. The roadway could thus accommodate three motor cars abreast, if necessary. The bridge, consisting of six bowstring arch spans, each 124ft. long, has been built throughout of reinforced concrete. Two arch ribs rising 30ft. high at the middle extend from end to end of each span on either side of the roadway. From these ribs, at intervals of 9ft., hangers consisting of steel bars encased in concrete extend downwards into beams that cross from side to side below deck level. The deck, a slab of reinforced concrete 10in. thick and continuous from end to end of the span, is supported by the beams. One end of each span is fixed to the pier on which it is resting, while the other end sits on heavy cast steel roller bearings. Each of these bearings, manufactured in Dunedin, comprises a nest of five rollers that allow expansion and contraction to take place as the temperature changes. They also allow for an infinitesimal rocking motion that results from the passage of heavy loads. The small gaps between the ends of adjacent spans are covered with rust-resisting steel plate set into the deck to carry the traffic. The bridge has been designed to resist earthquakes. Scientists have stated that no part of the country can be considered free from earthquake shocks, and the policy of the Public Works Department is to make provision for contingencies of this nature.

In the building of each pier two cylindrical shells of



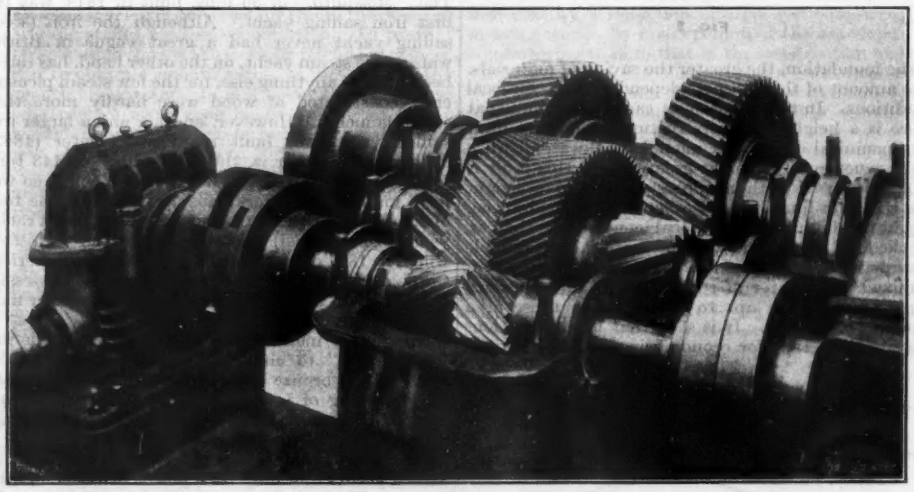
BALCLUTHA HIGHWAY BRIDGE, OTAGO

reinforced concrete, 8ft. in diameter, were sunk into the river bed until satisfactory foundations were obtained. Bores put down on the site before the bridge was started enabled the contractor to know almost exactly the foundation depth of each cylinder. Of the five piers, the northern three are founded on rock, while the two on the Balclutha side are founded on compact sand. After a cylinder had reached its final depth it was filled with concrete. Above water level the two cylinders of each pier are continued up to their final level, together with a connecting wall of reinforced concrete 3ft. thick. This wall or diaphragm firmly braces the pier in an up and downstream direction.

The Public Works Department had officers supervising the construction and carrying out exhaustive tests of the raw materials and of the finished concrete. A field laboratory was established on the job to enable the work to be done efficiently. As each portion was completed measurements of the finished structure were made in order to compare the stresses in various members of the bridge with the designer's calculations. The data obtained from these tests will furnish material for the economical design and construction of future bridges in New Zealand.

Cold Roll Drives.

Two interesting drives—one 85 h.p., the other 55 h.p.—have recently been supplied to the Yniscedwyn Tinplate Company, Ltd., of Swansea. It is interesting to note that these are the first all-electric cold roll drives to be installed in the Dawe Valley. They were designed and manufactured by David Brown and Sons (Huddersfield), Ltd., who acted as main contractors for the complete drives. The 85 h.p. set, which drives three sets of rolls, comprises a double-reduction helical gear, a "Radicon" worm reducer for barring purposes, main drive and barring motors, and motor control gear, all mounted on a common



85 H.P. GEAR DRIVE FOR COLD ROLLS

cast iron bed-plate. The drive is taken from an 85 h.p. motor running at 730 r.p.m., the driving shaft of which is connected by a pin-type flexible coupling to the high-speed shaft of the double-reduction unit. In this unit, double and single helical gears are employed at 12in. and 17in. centres, and transmit 85 h.p. when reducing from 730 to 47·7 r.p.m., or, alternatively, 15 h.p. when reducing from 31 to 2 r.p.m. of the rolls. The high-speed shaft of the helical gear is extended on the side opposite to the driving motor and connected by a spiral claw-type coupling to the low-speed shaft of the barring gear. The barring gear is an 8in. centre R.H.U. type "Radicon" high-duty, worm-reducing gear, driven by a 15 h.p. motor, which reduces from 960 to 31 r.p.m. By means of the claw-type coupling, the barring motor and gear are automatically cut out as soon as the barring motor is over-run by the main motor. The driven half of this coupling is provided with slots for hand barring purposes in the reverse direction to normal running, and is fitted with a shroud to prevent the insertion of the barring lever when the coupling is in engagement. Provision is also made to prevent starting up of the main motor unless the coupling is engaged. The driving shaft of the main gear is fitted with a rigid-type coupling incorporating a machined "wabbler" extension permitting slight malalignment between the rolls and gear shafts, which are thereby protected from undue strain and overload.

The drive is built up complete with electrical control equipment for operating the main drive and barring motors, the operation being briefly as follows:—The claw-type coupling is first engaged by hand, which operation closes the feed circuit to the push-button control station, when only the push-button for the barring motor start is energised. The main motor will not start until the barring motor is up to speed. On pressing the push-button the barring motor will accelerate through the medium of the control panel to 2 r.p.m. of the rolls. If the mill is now required to run at full speed the main motor can be started, and as it accelerates and overruns the barring motor, the claw coupling is automatically disengaged and the barring motor is shut down by operating the interlock unit switch. A "stop" button is provided to shut down both motors under all circumstances.

SIXTY YEARS AGO.

IN 1874 a prophet, Mr. W. R. Greg, had written in the *Contemporary Review*, under the title "Rocks Ahead," a gloomy anticipation of the conditions which British industry would in the near future be called upon to face. The time would come, Mr. Greg had said, when "coal, ceasing to be in such demand, will fall in price; the lower price will stimulate coalowners to inventions directed to economise the cost of raising it; colliers, being less sought after, will become redundant, and will ultimately (after fierce recalcitration and many wasteful strikes) accept lower wages; artisans in the iron trade, the cotton trade, and the rest, finding that far fewer of them are needed, will perforce be content with scantier earnings, and will be anxious to work longer hours." In our issue of August 6th, 1875, we remarked in an article entitled "Industrial Changes and Chances," that part of Mr. Greg's pessimistic prophecy had already been realised and that every item of it seemed likely to be carried out to the letter. The country had recently passed through a period of wonderful prosperity. The years immediately following the conclusion of the Franco-Prussian war had brought abundant trade to our mines and factories and prices of coal and other raw materials had risen greatly. Everyone thought only to make the most of the opportunity and few were prepared to believe, while they were on the crest of the wave, that it would carry them to a goal that would be otherwise than pleasant and profitable. In 1874, however, the depression began and rapidly intensified. Much of the prosperity which we had enjoyed was derived from the development of America, but the Americans had now begun to be self-reliant and in the future we could look upon their market as practically closed against us. Germany and France still largely imported coal from us but every other country, even India, China and Australia, was endeavouring to make itself self-dependent and was developing its coal resources with unparalleled enterprise. In all our other staple industries the same conditions prevailed. Russia, Germany, Spain, Belgium and even Turkey were entering upon a new career of industrial effort. We had been supplying the world with iron and we had taught the world how to make iron. The world was ungrateful and we must now, we said, pay the penalty. During the period of prosperity wages had risen, hours had been shortened, new and great factory extensions had been brought into being and money had been spent recklessly on enterprises which in ordinary times could never have shown a profit. That was the legacy which the period of prosperity had handed on to the period of depression to make what it could of it. The conditions of the past two or three years had passed away, probably, we said, never to return. Coal pits were now being closed down, blast-furnaces blown out and forges laid idle and in a few months thousands of able-bodied men would be without work and without bread. . . . It was a dismal picture but to us there is some consolation in it for we know that the country survived to regain a prosperity undreamed of by the prophets.

IN statistics relating to coal and oil fuel, and given in *O'Connell's Coal and Iron News*, it is shown that 3880 steamers of 19,885,070 tons are fitted for burning either coal or oil fuel, of which 807 of 5,244,082 tons are registered in Great Britain and Ireland, and 1545 of 7,919,355 tons are registered in the United States of America. Slightly over 50 per cent. of the tonnage of the world's merchant marine now depends entirely upon coal, while in 1914 the percentage was nearly 89. The tonnage of steamers using coal, which in 1914 reached 43,860,000 tons, is now 32,538,000 tons, or some 11,000,000 tons less.

Rail and Road.

The Road and Railway Transport Act (Northern Ireland), 1935, is now an accomplished fact as the Bill received the Royal Assent on July 16th.

The Glasgow Corporation is preparing a scheme for the electrification of the railways in that city and in the West of Scotland with a view to it being submitted to the Government and financial assistance obtained towards the carrying out of the scheme. Co-operation by all the town and county councils in the area is being sought. The L.M.S. and the L.N.E. companies have already agreed to join in the discussions.

Giving evidence as to the death in his own home of an engine-driver, aged fifty-eight, the Blackburn police surgeon advised that every railway engine-driver should be periodically examined for blood pressure; certainly if over the age of forty-five. We do not think that this remark should create any alarm as the railway companies watch very carefully the health of their drivers, especially after they have entered their fifty-sixth year.

The new station at Elm-park, on the Barking-Upminster section of the L.M.S. Railway, which was opened on May 13th, has a platform roof of welded construction, the first of its type in this country. As much as possible of the fabrication was done in the shops. The welded connection of the main cross members to the stanchion tops had to be done on the site by overhead welding, but no difficulty was experienced in making the weld seams in that position.

It is officially announced that the London and North-Eastern Railway has decided to convert to electric traction the line, 11 miles long, between Newcastle and South Shields. The work will be operated in connection with the electrification of the Tynemouth branches on the north side of the Tyne. The latter has a route mileage of 29·5, the equivalent single track mileage, including sidings, being 75. It was opened on July 1st, 1904. Part of the present scheme is the provision of 131 new vehicles, when 90 of the present coaches will be scrapped.

The London, Midland and Scottish Company reports that the increase in receipts for the half-year ended June 30th, when compared with the corresponding period of 1934, was £200,000, but that amount was wiped out by increased expenditure of a similar amount. Salaries and wages in "railway working" accounted for £170,000 of the greater cost. The L.N.E.R. recorded not only a decrease of £74,500 in receipts, but an increase of £252,400 in expenditure. Salaries and wages were £227,800 higher. The Great Western had an increase of £35,000 in receipts and a rise of £18,000 in expenditure. The Southern passenger traffic advanced by £135,000, but the goods traffic fell by £165,000. The expenditure being £45,000 higher, the net result was therefore £75,000 less.

The past few days have seen the anniversaries of the openings of two important railways. It was thirty-five years ago on July 30th since the Central London was opened, which, at that time, ran from the Bank to Shepherd's Bush. It was sanctioned in August, 1891, and was informally opened by the then Prince of Wales—afterwards King Edward VII—on June 27th, 1900. For many years it had, like the rapid transit lines in America, a uniform fare, regardless of distance, which led to its popular name of the "Tuppeny Tube." On August 2nd it was sixty years since the Midland Company's Settle and Carlisle line was opened for goods traffic, giving that company an independent route to Scotland. The latter line was opened for passenger traffic on May 1st, 1876.

A recent issue of the *London and North-Eastern Railway Magazine* referred to New Mills Station, Derbyshire. Its mention prompts us to relate how that station figured in the access of the Midland Railway into Manchester. The Manchester, Sheffield, and Lincolnshire had a line from Hyde to Marple, which was, on July 1st, 1865, extended to New Mills and afterwards by a single line to Hayfield. The Midland line, going in the Manchester direction, ended at Buxton, but, under powers given in 1862, a railway was built from Millers Dale to New Mills, which was opened on January 24th, 1867. The New Mills–Hyde line became the joint property of the two companies, and the Midland thus ran into London-road Station, Manchester. The joint companies' direct route from Romiley, through Reddish, to Ashburys, was opened on August 2nd, 1875, also a connecting line from Romiley to the Cheshire Lines Committee's railway.

In this column on March 22nd, we recorded that a gateman had been committed for trial on a charge of manslaughter arising out of the driver of a road motor van having been killed following a collision of his vehicle with a passenger train at public road level crossing No. 5, between Barkston and Honington, on January 24th. As the man was found "Not guilty" at the Lincoln Assizes on June 7th, the report by Colonel Trench on the accident has been released. Whilst the crossing was, as said above, that of a public road, it was not protected by the standard equipment of gates that close alternately across road and rail. The gates, 12ft. wide, opened away from the railway, and were held by a spike in the open position. They were not, of course, interlocked with any signals, and were worked individually from the ground by a gatekeeper, who had to be guided as to the approach of trains by indicators working with the block instruments of the box on each side of him. A motor car had crossed just previously and the gatekeeper thought that there was time to let the motor van follow. That was not the case, and the accident followed. Whilst modern gates and signals would be the correct equipment, Colonel Trench hardly feels justified in recommending them as a matter of urgent importance, as the road traffic is light and the conditions are not difficult. Moreover, standardisation at that crossing might prejudice the modernisation of other crossings where it may be more urgently required. The report concludes thus: "Cases such as this, where a road vehicle is involved in an accident at a public road level crossing, through no fault of the road driver, are fortunately rare. Their rarity is a tribute to the competence and vigilance of crossing keepers in general, and their occurrence is a reminder that this standard must not be relaxed."

Miscellanea.

Nozzles of boron carbide for sand blasting plant have been successfully tried out in America. They are stated to have a working life of at least 750 hours with silica sand and 1500 hours with steel grit.

The Holland County Council has decided, subject to ministerial sanction, to carry through an extended plan of reconstruction of both roads and bridges in the Lincolnshire Fens, at a cost of over half a million pounds.

A new battery of fifty-nine ovens is being erected at Brancepeth Colliery, Willington. The plant includes a full by-product recovery system, which, together with the laying of the pipes, will cost over £200,000.

The Gross-Glockner transalpine highway was opened on August 3rd by the Austrian President. The road, which is the second highest motor road pass in the world, took some five years to build, and reaches a height of 8000ft. above sea level at the Hochtor.

Arrangements are being made in the U.S.S.R. for a 13,800 kilom. marathon motor car race for Soviet cars. A note says that the route will be from Moscow through Kazan, Kazalinsk, Chimkent, Frunze, Alma Ata, Karaganda, Kustanai, Cheliabinsk, Sverdlovsk, Perm, Kazan, and finishing at Moscow.

It is expected that work will begin early in 1936 on the construction of the high-level bridge over the Clyde at Finnieston, Glasgow. Over £400,000 has been spent on the purchase of land and buildings for the preparation of sites, and it is estimated that the construction of the bridge will cost £800,000.

To ascertain the best protection for exposed steel structures with a view to the painting of towers used for power transmission lines, tests have been carried out in France. The conclusion reached was that the best protection against corrosion for structures of this type is a paint on an oil base, or, better still, aluminium on a base of coal tar pitch.

The Minister of Transport recently announced that with the approval of the Chancellor of the Exchequer he intended to increase the grants to councils for road-making purposes. According to his statement, the existing flat rate for Class I roads of 60 per cent. is to be increased to from 75 to 85 per cent., and for cycle tracks and dual carriageways grants are to range from 60 to 75 per cent.

According to a committee appointed by the Manchester Corporation to report upon the practicability of making available to the public smokeless fuels, including gas and electricity, and thus definitely contributing to a cleaner atmosphere, the committee stated that smoke from household grates was responsible, approximately, for three-quarters of the total smoke in the atmosphere.

Early in September regular production of thousands of gallons of petrol and heavy oil on a commercial basis will begin at the Seaham Harbour plant of Coal and Allied Industries, Ltd. The first unit of the plant will use 500 tons of coal per day, and the output will be 10,000 gallons of first-grade petrol, 10,000 gallons of heavy oil, 200 to 250 tons of coke, in addition to other important by-products.

In accordance with a resolution approved by the Italian Paper and Printing Guild, a National Cellulose and Paper Corporation will be set up and an experimental station will be opened to promote the manufacture of cellulose, utilising for this purpose Italian raw materials, more especially Lybian esparto grass and the straw and hemp stalks of which very large supplies are available in South Italy.

A new series of free-cutting aluminium alloys is reported from America, says *Iron and Coal Trades Review*. These new alloys, it is claimed, offer many opportunities for the economical production of parts for a wide variety of structural assemblies. They are resistant to tarnish and corrosion. Very high yield, tensile and shear strengths are obtainable, and the alloys compare favourably with duralumin and free-cutting brass.

The first commercial oil-drilling operations in this country since the passing of the Petroleum (Production) Act are expected to begin in October in Worth Forest, near Three Bridges, Sussex. The cost of the first well is expected to be £25,000, and will be sunk to a minimum depth of 3000ft. For the purpose of the operations, the N.M.D. Syndicate, Ltd., has already put down an experimental well near Three Bridges.

Figures issued by the German Reich Coal Council show that the world production of coal in 1934 was 1,367,200,000 tons, or 95,300,000 more than in the previous year. European percentage remains at 52·1, while that of America rose from 35·7 to 35·9. Turnover in world foreign trade totalled 247,000,000 tons, an increase of 15,000,000 tons. Germany, Poland, and Czechoslovakia being among the principal countries to benefit.

The rail and road transport of metallic sodium in tank wagons has been commenced by the Roessler and Hasslacher Chemical Division of the du Pont Company. According to the *Chemical Trade Journal* the sodium is filled into the wagon in the molten condition after the air in the wagon has been displaced by nitrogen. Steam coils built into the tank wagon provide for the melting of the sodium prior to unloading. The wagons are constructed to carry about 80,000 lb. of metallic sodium.

Tungsten plating has a bright silvery lustre, but, unlike chromium, it is not attacked by any of the common mineral acids, and can be dissolved by a mixture of nitric and hydrofluoric acids, says an extract in *Iron and Coal Trades Review*. A thick coating of metallic tungsten can be plated electrolytically and is especially valuable for covering baser metals in laboratory ware. The metal is not affected by sulphur or phosphorus. It has a hardness on Mohr's scale of about 7. Tungsten plating solution is easy to prepare. A saturated solution of sodium carbonate is made at 100 deg. Cent. and tungsten trioxide, WO_3, is added as long as the sodium tungstate formed is soluble. The solution is electrolysed usually at 75 ampères per square foot, and the higher the temperature the brighter the deposit. The solution is not entirely stable, and will slowly deteriorate when used constantly.

Air and Water.

A new aerodrome covering some 360 acres and costing £40,000 is being planned for Hastings.

After a year's work, the German 26,000-ton battleship "König Albert," sunk at Scapa Flow, has been salvaged.

Aircraft material to the value of £1,486,950 has been exported from this country during the first six months of this year.

The new Orient liner "Orion" attained a speed of 21·66 knots when recently completing successful trials in the Firth of Clyde.

The Air Ministry has ordered a number of a new type of light bombing machines which are said to be capable of a speed of 275 m.p.h.

Vessels of the Anchor Line are shortly to cease using the docks at Birkenhead for loading purposes. They will use the docks on the Liverpool side of the Mersey.

The French Farman "F 1001" experimental monoplane, specially designed for stratosphere flying, recently crashed on the road between Mantes and Rouen.

The entire crew of fifty-five were lost in the Soviet submarine "B 3," which recently sunk after a collision in the Baltic Sea. The vessel has been raised and taken to Kronstadt.

With a view to expanding Australian trade, the Government is planning to send a trade mission ship carrying Australian products to Singapore, Japan, China, and India.

On Sunday last an officer and an aircraftsman were killed in a Demon two-seater fighter, which crashed on the railway line just after the machine took off from Hendon Aerodrome.

A daily air service from the Liverpool airport at Speke to Norwich, Nottingham, Northampton, and Bristol, with connections to other parts of the country, has been opened by Crilly Airways.

Soon after leaving St. Helier on Saturday afternoon last the Southern Railway cross-Channel steamer "Princess Ena" caught fire and had to be abandoned. The vessel eventually sank twenty-four hours later.

Using the two floating aerodromes, "Westfalen" and "Schwabenland," the German Lufthansa Company plan to make a trial flight for an air mail service over the North Atlantic between Europe and North America.

The first of the two large mail liners being constructed by Harland and Wolff, Ltd., for the Union-Castle Mail Steamship Company, Ltd., will be launched at Belfast on August 15th. The ship will be named "Stirling Castle."

The two new Douglas air liners ordered for the Polish Air Transport Company have been fitted with Bristol "Pegasus III" engines. According to a report, the speed of these new machines at an altitude of 12,000ft. was 180 m.p.h.

Germany's first full-sized fighting ships, the two 26,000-ton battle cruisers, begun last autumn, are approaching the launching stage. They will be named "Scharnhorst" and "Gneisenau," after the famous armoured cruisers of von Spee's squadron.

A new French submarine, named "La Perle," has been launched at Toulon. The vessel has a surface displacement of 760 tons, and submerged 895 tons. It has a speed of 12 knots, and its armament consists of two torpedo tubes, a 75 mm. gun, and a machine gun.

It is stated that an ambitious plan for air expansion in Japan has been decided on by the Imperial Aviation Association. It includes the provision of 300 new aerodromes and the organisation of volunteer flying corps. The Association also intends to help private air organisations as much as possible. Schemes are also afoot to improve light aeroplanes and encourage gliding.

When the French liner "Normandie" is laid up, from the end of October to the beginning of March next year, at Havre, various adjustments, which service experience has suggested, will be made. During her stay at Havre in the winter, the "Normandie" will, as already announced in The Engineer, have her stern stiffened and braced to counteract vibration.

In conjunction with the Treasury, the Ministry of Agriculture has sanctioned the application for a grant towards the second part of the river Nene improvement scheme. The second part of the scheme provides for making the river Nene more navigable from Northampton to the estuary. The estimated cost of the work is £379,000, towards which a grant of 60 per cent. is being made.

According to the Moscow correspondent of the *Manchester Guardian*, the historic "Maryinsky Waterway," a series of rivers and canals which connect the Baltic with the Volga, is to be enlarged into a modern canal capable of bearing large cargo vessels. The extension of the system will connect Moscow with Leningrad and the Baltic, the White Sea, and with the Volga. Additional value will be given to the Maryinsky project with the completion of the Volga-Don canal to connect the Volga with the Black Sea. Work on this is to be started in 1936, and when it is finished vessels will be able to pass from the Arctic to the Black Sea, facilitating the exchange of such products as Northern timber for Donetz Basin coal.

The King's Cup Air Race, 1935, will take place at Hatfield Aerodrome on Friday, September 6th, and Saturday, September 7th. The eliminating contest on the first day will be in the nature of a straightforward "scratch" race, with the competing aircraft divided into two classes: (*a*) Those with a total engine horse-power not exceeding 150 b.h.p., and (*b*) those exceeding this power. Ten machines in each of the two classes which complete the eliminating course in the shortest time will pass into the final, and will race on estimated performance handicaps issued prior to the start of the first day's race. An innovation this year is a "field" of the twenty fastest aircraft racing altogether in the final non-stop over a course of 350 miles composed of seven laps of a 50-mile circuit.

BOUQUET CANYON RESERVOIR AND PIPE LINES, CALIFORNIA

(For description see page 134.)

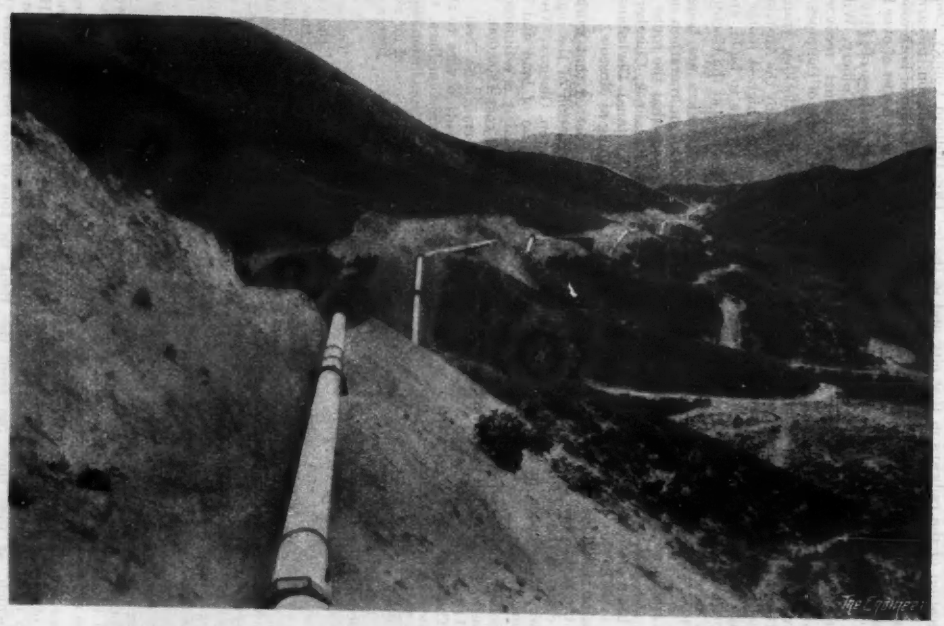


FIG. 6 (ABOVE):—SHEEP'S-FOOT ROLLERS COMPACTING IMPERVIOUS SOIL
FIG. 7 (BELOW):—UPSTREAM FACE OF DAM AFTER COMPLETION

FIG. 8 (ABOVE):—PLACING CONCRETE SLAB ON UPSTREAM FACE OF DAM
FIG. 9 (BELOW):—THE FINISHED PIPE LINE

The Engineer

AUGUST 9, 1935.

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NOTICES TO READERS.

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CHANGES OF ADDRESS.

*** *Will subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

THE SOUTH AFRICAN IRON AND STEEL INDUSTRY.

THE South African iron and steel works at Pretoria appear to be meeting with the difficulties inherent upon the establishment of such an industry in days of strenuous world competition. South Africa has been regarded as a valuable export market by British, Continental, and American steel makers for many years, and suggestions that a State-owned steel works at Pretoria could, within a comparatively short time, be a profitable undertaking without being a burden upon the taxpayers, either directly or indirectly, err on the side of optimism. Our Cape Town correspondent in his notes in this issue deals with the address to the shareholders of the South African Iron and Steel Corporation—Iscor—at the end of June. There are no public shareholders in this concern, the State holding most of the shares, but some debentures are held by the Commissioners of Public Debt. Those who recall the brilliant hopes with which the Pretoria Steel Works were founded will observe that these expectations have not so far been realised. At various times before their opening, Dr. van der Byl expressed confidence in the successful career of the undertaking as a profit-maker, and stated that shortly after starting operations the works would be able to produce steel at a cost very close to that of the British and Continental works, and that once in full swing they would produce at lower costs than those sources of supply. Considering that there has always been a difference of two or three pounds in the price of Continental and British steel, it is rather difficult to explain precisely what was in the mind of the chairman of the South African company. However, he claimed that the Pretoria Works would enjoy the advantage given by its proximity to the Witwatersrand goldfields, while overseas products would have to pay heavy carriage on their conveyance from the coast ports to the field, a distance of over 900 miles. Apparently, however, these conclusions did not take into account the strength of the foreign competition it would be necessary to meet in South Africa. Belgium is now reported to be selling in the South African market, whilst in the last month or two the State Railways have made important purchases of rails and plates from Hungarian works. These facts are unfortunate in face of Dr. van der Byl's statement that when the works were running full, as they have been doing for several months, they would produce as cheaply as any in the world. Another complaint heard in South Africa is that the promise of the late Government that the establishment of the new works would cheapen the cost of all steel products to the consumer is not being fulfilled.

It may be assumed that the sale of Belgian steel at below the Iscor prices is one of the consequences of Belgian steel exports to the United Kingdom having been reduced to nearly half. This reduction, of course, has compelled her to find other markets. Some of the Belgian steel works are believed to be the cheapest producers on the Continent, and charges that their prices are unremunerative, or that they are practising dumping, would be hard to prove. In any case, competition is not confined to Belgium or Hungary, and it is reasonable to suppose that the steel industries of other countries will not lightly surrender their foothold in the South African market. The Pretoria works have a manifest advantage in their close proximity to the greatest market in the country—the Witwatersrand goldfield; but on the other hand, South African production costs are high. Imported workmen demand high wages, and it remains to be seen whether public policy will permit of native labour, if suitable for heavy furnace and forge work, being used in order to keep down working costs. The South African public is beginning to urge the Government to make a statement on the prospect of the industry. Moreover, there are experts in steel manufacture in South Africa who doubt the wisdom of the extensions which have been decided upon. These include another blast-furnace, an increase in the capacity of the heavy rolling mills, and the erection of foundry and plate mills in order to meet a current demand which is abnormal. The gold-mining industry does not dream of a continuance of the present boom, but it is the activities attendant upon these conditions which have been calling for thousands upon thousands of tons of machinery, plant, and materials each year since the Union went off gold, and which are responsible for the demands upon Iscor. Should these requirements decline, Iscor would again be faced with conditions of restricted production, similar to those to which Dr. van der Byl attributes the high unit costs in 1934. In view, however, of the large capital of the works—now five and a half million pounds, with a prospect of rising to seven million pounds—full-scale employment is necessary to pay the annual interest.

Dr. van der Byl, complaining about dumping, said: "The Government will take steps to safeguard the works against dumping; but the Continental nations which send steel to South Africa have a powerful means of retaliation at hand, since they are customers as well as suppliers, and any measures taken to safeguard Iscor in that way, would, it is feared, react heavily on other of the Union's industries." Dr. van der Byl further stated that "we ought to be able to make the industry pay without making it a burden upon the people"; but it may not be easy to give practical effect to this statement. South Africa, it is true, has large sums at stake in the iron and steel industry, but if it is to be a national asset it must stand on its own feet. The cost of producing pig iron and steel ingots at Pretoria is now at or near the British level. That may be satisfactory, so far as it goes, to British producers; but by many users in South Africa it is not regarded as a sound measure of the economics of Iscor. Belgium and other Continental countries can produce far more cheaply than Great Britain, and at the present time are, in fact, sending thousands of tons of steel sleepers to the Union Railway Administration. The imports of British steel into South Africa also are considerable, and it may be that the British steel makers would be the first to feel the establishment of an efficient South African steel industry. On the other hand, the whole structure of the world's steel industry is changing, and it may be found that when the promised agreement is reached between the British steel makers and the Continental Steel Cartel the tonnage of Continental exports to South Africa and the prices at which they are sold, may undergo considerable modification. This should help the South African steel works, but if this benefit takes the form of increased sales it will mean smaller exports for both Great Britain and the Continent, which could only be made good by more profitable prices. It seems possible therefore that in the end the South African consumer may have to pay higher prices to solve the difficulties of both the home and foreign sellers in his market.

Metallurgy and the Physicist.

THE sciences can be broadly divided into two groups. On the one hand, there are those such as heat, light, and electricity, in which, after the laborious collection of data for many centuries, man has found it possible to "organise" the known facts into generalising laws; and, on the other, are to be placed the less perfected sciences, such as meteorology and metallurgy, in which despite a wide and detailed knowledge no laws of such wide scope appear to be applicable. In the greater part of his work, fortunately, the engineer is concerned only with sciences which fall within the former group. If it were not so, in fact, it may be doubted whether to-day the productions of engineers would be so prominently displayed upon the surface of the earth. In the design of a reciprocating engine, for instance, it is not necessary for the engineer to study experimentally the effects upon the compression and expansion of the gas of varying the diameter of the cylinder or the stroke of the piston. These effects are directly predictable out of a knowledge of the laws of steam or gases. Similarly, without experimentation the electrical engineer can predict from known laws the exact effect of a device he may insert in a circuit; while the hydraulic engineer, although he is dealing in some respects with a less exact science, has such theorems as Bernouilli's to fall back upon.

But unfortunately it seems to us that one of the sciences in which the engineer is very closely interested must still be classed in the less complete of the two divisions. No engineer at the present time can feel fully satisfied with the state of the science of metallurgy. Full credit must be given to the workers in this field for the great advances, resulting in the production of alloys with novel and invaluable properties, which have been developed within comparatively recent years. But it is, nevertheless, only necessary for a student to attend a meeting of the Iron and Steel Institute or the Institute of Metals, or to read a few numbers of our Supplement THE METALLURGIST, for him to realise that, despite the collection of an enormous load of detailed data, progress towards a real understanding of the underlying reasons for the various properties discovered has been, and still remains slower than is desirable. In the development of new alloys it is still necessary to proceed very largely by a method of trial and error until the desired properties are obtained, and although past experience embodied in minor laws can give some indication of the most promising path to follow, it is quite unable to predict exactly to what point the investigator will be led. There is no "arterial" road from which the research worker can break off on to little-known side tracks, but only, as it were, an agglomeration of streets, some of which travel far, while others are hardly started. Owing, probably, to the great difficulties attendant upon researches, such, for instance, as the trouble of obtaining really pure materials to which Sir Harold Carpenter referred in his Presidential Address to the Iron and Steel Institute, the influence of alloying materials on such properties as creep, corrosion, and fatigue resistance, is very imperfectly understood. When the great number of alloying materials is considered, and it is also remembered that two, three, four, five, or more may all be present in the final alloy, it will be realised that the number of variations must be enormous. Without great generalising laws to aid him in his task, the investigator in this field seems doomed to employ trial-and-error methods for hundreds of years hence before all the possible variations can be tried.

It is recognised that if metallurgy is, within the near future, to be placed among the "organised" sciences, the research required is not so much that on the development of particular alloys with special qualities, but upon the fundamental structure of metals and other materials. The ability to resist corrosion, for instance, is a chemical or electrochemical attribute of the material which is already beginning to be better understood as the result of an increasing knowledge of the methods of and reasons for the chemical combinations of atoms. Similarly, it has been held out as a possibility that the molecular structure of the crystals of a material may bear a fundamental relation to its

physical properties. Unfortunately, as Sir William Bragg pointed out in a recent lecture before the Society of Engineers—which we give in abstract form on another page of this issue—estimates of the force necessary to tear apart the molecules in a crystal are very far from agreeing with the results of a practical trial of the material. The estimate, in fact, is of the order of two hundred times too great. Though the discrepancy is so large as to suggest that other factors than crystal strength predominate in determining the properties of the material, the very fact that such an estimate can be made as the result of an X-ray analysis is a great advance. Moreover, the technique by which it has been achieved, combined, for the purposes of solving some of the intricate calculations involved with the use of the differential analyser described in our issues of July 19th and 26th, is already throwing light upon phenomena which had resisted other means of investigation. Dr. Griffith, of the R.A.E. at Farnborough, has put forward the suggestion that the discrepancy lies in the presence of minute flaws too small to be seen by the microscope, and yet too large to be revealed by X-rays, situated, presumably, between the various crystals making up the whole. The practical strength of a material, in fact, appears to lie rather in the arrangement of the individual crystals and the means by which they are bound together than in the molecular arrangement. By the development of some means of testing Dr. Griffith's hypothesis and of examining the structure in this way, it may be hoped that some fundamental law will be discovered. At least, the method will have the advantage that a direct approach upon the heart of the problem will be made.

Obituary.

GEORGE ROLLO.

British shipowners and their marine engineers will learn with regret of the death of Mr. George Rollo, the former head of the Liverpool engineering firm of David Rollo and Sons. Mr. Rollo, who died on Friday, August 2nd, at his home, "The Park," Waterloo, Liverpool, was in his eighty-third year. He was born in Glasgow, and was the eldest son of the late Mr. David Rollo, of Glasgow and Liverpool, who founded the Liverpool firm of David Rollo and Sons. Mr. George Rollo served his apprenticeship as an engineer, and worked in Liverpool, Stockton-on-Tees, and in Glasgow, with various marine and general engineering firms. In 1877 he became a partner with his father in the business of David Rollo and Sons at the Fulton Engine Works, Liverpool. On the death of Mr. David Rollo, senior partner, and at the close of the war, the firm became a limited company, and Mr. Rollo's son, Lieut.-Colonel George Rollo, was appointed its managing director. Some nine years later the engineering business was amalgamated with the ship-repairing business of H. C. Grayson, Ltd., under the title of Grayson, Rollo and Clover Docks, Ltd., and Mr. George Rollo ceased to take an active part in the business. He was well known in Lancashire and his death will be regretted by many friends.

G. BERTRAM KERSHAW.

Many of our readers, especially those associated with water and sewage schemes, will regret to learn of the death on Thursday, July 30th, of Mr. G. Bertram Kershaw, the senior partner of G. B. Kershaw and Kaufman, consulting engineers, of 9, Victoria-street, Westminster, who for many years was engineer to the Royal Commission on Sewage Disposal. He was educated at Malvern and obtained his first experience of sewerage, sewage disposal, and water supply as assistant to Messrs. John Taylor and Sons and Santo Crimp.

At the inception of the Royal Commission on Sewage Disposal he was appointed engineer to the Commission, in which capacity he did excellent and outstanding work over a period of sixteen years. The work which he accomplished during these years can to some extent be appreciated by those who have studied the voluminous reports presented by the Commission.

When the Commission was dissolved in 1914, Mr. Kershaw started in private practice as a consulting engineer and the experience he gained whilst acting as engineer to the Royal Commission proved of inestimable value to him in the many sewerage, sewage disposal, trade waste, and water supply schemes he designed and carried out for a large number of local authorities, manufacturing and industrial undertakings.

In 1911 he published his well-known book on "Modern Methods of Sewage Purification," and in 1914 a further work entitled "Sewage Purification and Disposal," of which a second edition appeared in 1925. He was also the author of several other publications, and a number of articles written by him on the subject of treatment of trade wastes were published in technical journals from time to time.

The work upon which he was engaged took him to America, and he was elected a member of the American Society of Civil Engineers and other American bodies. He also visited Egypt and India to advise the towns of Khartoum and Bombay on their sewerage and sewage disposal problems.

He was a member of the Institution of Civil Engineers, the Association of Consulting Engineers, the American Society of Civil Engineers, a Fellow of the Royal Sanitary Institute, a Fellow and Past-President of the Institution of Sanitary Engineers, a member of the Institution of Water Engineers, and of other learned societies connected with his profession.

The death of Mr. Kershaw at the comparatively early age of sixty years, will be deeply regretted by a very wide circle of friends, and by many to whom his many-sided work has been of great help.

In 1931 Mr. Kershaw took Mr. H. P. Kaufman into partnership and altered the name of the firm to G. B. Kershaw and Kaufman; the firm will, we are informed, continue to practice without change of name.

JAMES HENRY RONALDSON.

The death took place on Monday, August 5th, at his home, Oak Hill Drive, Surbiton, of Mr. James Henry Ronaldson, who was known throughout the British Empire and in many other countries as an independent consulting mining engineer and geologist. Mr. Ronaldson received his education and scientific training at the Universities of Edinburgh and Liege, and spent several years in Australia in the coal industry and in South Africa, where he built up a large practice as consulting mining engineer. He returned to London a few years before the war and practised as an independent consulting engineer. During the war he served in the Ministry of Munitions and was later transferred to Brotherton and Co., Ltd., with which firm he remained engaged in the manufacture of munitions until about the end of the war. He resumed his practice as a consulting engineer after the war and travelled widely and for some years carried on a consulting practice with Dr. William Cullen. More recently he specialised in administration and was a director of several mining companies, his wide experience proving of great value. He was a member of the Institution of Mining Engineers, the Institution of Mining and Metallurgy, and a Fellow of the Geological Society. He was looked upon as perhaps the senior engineer in his particular branch and his death will be regretted by a very wide circle of business and private friends.

Literature.

The Gantt Chart. By Wallace Clark. London: Sir Isaac Pitman and Sons, Ltd. 1935. Price 7s. 6d. net.

The author takes no credit to himself for the scheme propounded in his work, and definitely acknowledges his indebtedness to Henry L. Gantt, who, he says, "placed service to others before profit to himself," but he demonstrates in a very orderly manner the value of the Gantt Chart, and its wide sphere of application.

In addition to a very clear description of the chart itself, this book is an undoubted aid to management, in that it shows how the systematic utilisation of charts can be made not only to throw up in bold relief the weaknesses of an organisation, but also to do so in a manner calculated to suggest remedies.

The main principle of the Gantt chart is that work planned and work done are shown in the same space in their relation to one another and in their relation to time. Exactly the same type of chart is used to set out the loading of machine tools, hammers, &c., as is used for *personnel*, for planning, for progress, and even for the guidance of staff. This idea has the great advantage of presenting the full facts in a manner readily understood by all officials, even including the more intelligent shop operatives. That charts of this sort can be of great assistance in budgeting for the future has been abundantly proved. The author devotes a chapter to each of the different spheres of an organisation, his descriptions being most lucid, while most of his typical charts will be found almost self-explanatory.

Very far-reaching claims are made by Mr. Clark for the benefits to be derived from the use of Gantt charts, including that of maintaining machines and equipment in good condition, of utilising floor space to the best advantage, of ensuring the rapid handling of work from operation to operation, leading to increased production, not at the expense of the workman, but by the removal of obstacles. If the foregoing be allowed, it is a natural corollary that costs will be reduced, and idle hours brought down to a minimum, while great assistance should be rendered to a staff, no longer overburdened with extraneous duties, and a foreman will "not have to get away from his desk in order to think clearly," because a comprehensive picture is ever laid before him.

After studying the different charts, and the method of their operation, the claims enunciated do not appear to be excessive, but we cannot help feeling that there is one very definite drawback, and that is to be found in the varying scale that is necessary to represent work, whether contemplated or performed. Whereas in setting out the chart, the spaces are equally divided as regards time, no such rule applies to the work scale, for even though the anticipated output in one week is double that of the preceding week, the thin line representing the output reached will have a different value week by week. When the heavy line, representing cumulative output, is plotted, this change of scale is somewhat bewildering, and must always be borne in mind. Although at first it may be difficult to realise that a line an inch long represents a hundred completed articles, while a line of similar length will stand for two hundred next week, after operating the chart for a short time this objection is minimised.

As an instance of the comprehensive utilisation of these charts might be mentioned a lay-out of the stenographic department of a business, which gives valuable information regarding the individual duties of each girl, showing when she is available, and for how long she is likely to be occupied. Most directors probably have a lingering suspicion that their typing section is not fully loaded, and yet frequently experience difficulties in ensuring the dispatch of letters on the day that they are dictated. They will be surprised at the increased efficiency possible with the assistance of a chart.

We cannot hope to mention all the unusual functions which Mr. Clark would govern by charts, but we are shown how executive direction can be assisted, and how the number of accidents can be reduced when appropriate charts are maintained and intelligently followed.

While we might not be prepared to go as far as the author in affirming that "the Gantt chart is the most notable contribution to the art of management made in this generation," after perusing his treatise we are prepared to admit that a very valuable contribution has undoubtedly been made, but to assess its value relative to other modern developments—*e.g.*, an up-to-date cost accounting system—is not an easy matter.

SHORT NOTICES.

Aeronautics: Handbook of the Collection Illustrating Heavier than Air Craft. Science Museum. Price 2s. 6d. net.—This is a second and revised edition of the handbook to the wonderful aeronautical (heavier than air) section which very properly attracts a great deal of public attention on the ground floor of the still new Science Museum in Exhibition-road. The collection became a separate entity in 1919, and has gone on increasing in importance, in size, and in excellence of display ever since. It is now, we are assured, and readily believe, the finest aeronautical collection in the whole world. Amongst the latest acquisitions is the famous Supermarine Rolls-Royce seaplane S 6 B, which won the Schneider Trophy in 1931, with a speed of over 340 m.p.h., and reached 407·5 m.p.h. for a three-kilometre burst. The volume before us comprises two main parts, the first a general history of human flight since the earliest times up to the recent present, and the second a descriptive catalogue of the exhibits. The first plate is reproduced from the tomb of Rameses III, *c.* 1100 B.C., and shows that pharaoh seated but provided with large dependent wings. It is a bold suggestion that this is an early manifestation of man's desire to fly. Were not wings—in this as in other examples—symbolical of a higher, more ætherial existence than designs for actual flying devices or manifestations of a desire to emulate the birds?

Electric Melting Practice. By A. G. Robiette. London: Charles Griffin and Co. Price 15s.—The author's object in writing this book has been to outline metallurgical practice as carried out in the melting furnace rather than to give descriptions of the constructional details of plant. Due attention is paid, however, to departures from orthodox practice. No pains have been spared, for example, to acquaint the reader with the details of present-day coreless induction furnace installations. An endeavour has also been made to discuss the requirements of metallurgical process in relation to the type of furnace which has been found to be most suitable. The author's opinions and conclusions regarding examples of actual practice are recorded, and as far as possible opposing opinions are discussed. Historical development of long standing is neglected in favour of the phenomenal progress witnessed during the last ten years. The book has the merits of being practical and of being up to date, and should appeal to many engaged in the important business of melting with the aid of electricity.

BOOKS RECEIVED.

Instruments. Second edition. By R. W. Sloley, M.A. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 5s. net.

Steel and its Heat Treatment. Third edition. By D. K. Bullens. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C.2. Price 25s. net.

Elementary Building Geometry. By G. A. Hanby, M.I. Struct. E. London: Ed. Arnold and Co., Ltd., 41, Maddox-street, W.1. Price 3s. net.

The New Architecture and the Bauhaus. By W. Gropius, translated by P. Morton Shand. London: Faber and Faber, Ltd., 24, Russell-square, W.C.1. Price 6s. net.

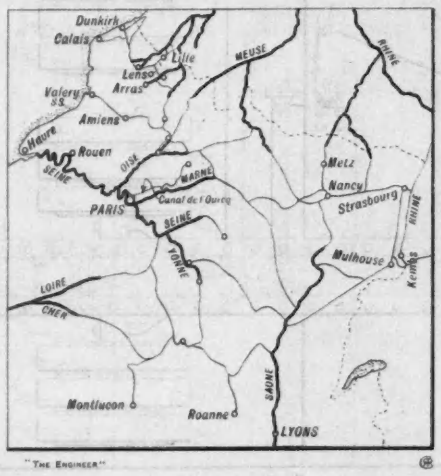
Higher Control: A Manual for Company Directors, Secretaries, and Accountants. Second edition. By T. G. Rose, M.I. Mech. E. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, W.C.2. Price 12s. 6d. net.

French Inland Waterways.

THE economic utilisation of inland waterways for goods transport depends upon geographical and industrial conditions and on competitive advantages offered by railways. Hence it is not always easy to draw the line where the working of canals is justified in the interests of users as well as of those who provide the capital to construct and maintain them. In the case of French canals, the capitalist is the State, which, as guardian of national property, is obliged to place national interest above profit-making considerations. Its duty is to equip and maintain canals for the benefit of users. Before the war there was a complete absence of traffic organisation which was detrimental to the working of canals, and in 1912 the State created an Office National de la Navigation with the object of equipping them and imposing such regulations as were necessary. But little could be done before the outbreak of hostilities, and after the Armistice the programme had to be developed and modified to adapt the canals to modern traffic conditions. The programme included electrifying canals, increasing their section, constructing bigger locks, extending ports, and creating new ones. Inland waterways participated largely in the scheme of national economic equipment. Between 1919 and 1934 a sum of 2000 million francs was spent upon them, provided as to 200 millions by public and private bodies, the remainder by the State. This expenditure enabled engineers of the Ponts et Chaussées to carry out a considerable amount of useful and interesting work on the navigable rivers and canals, and though much remains to be done, the mechanical and electrical equipment has greatly increased the efficiency of water transport over most of the system. Whilst these improvements were taking place in the conditions of inland water transport, the railways were becoming entangled in serious financial difficulties. They are as much national property as the canals, and will revert to the State when the companies' concessions expire in about sixteen years' time, so that the future of the canals had to be considered in relation to the interests of railways. The latter threatened to succumb to an intolerable burden of State charges, while the charges on canal traffic had to be limited to very moderate lock dues because the nature of that traffic put taxation out of the question. The railway companies complained of what they regarded as unfair conditions of competition which contributed to their increasing deficits, and the State has been doing its best to arrange for an equitable distribution of goods transport. A solution of this problem underlies the policy which the State is endeavouring to pursue with the object of organising all forms of transport in accordance with modern economic requirements.

The importance of inland waterways in relation to competitive transport may be gathered from the latest statistics available for 1932 showing the total length of the canals to be 3307 miles and of navigable rivers 5241 miles. Of these totals, 3194 and 3390 miles respectively are worked by companies holding concessions from the State. The total amount of traffic on the waterways in that year was 50,934,000 tons. The nature of the goods is indicated by the following categories :—Coal, 15,480,900 tons ; building materials, 19,797,960 tons ; manure and fertilisers, 1,589,200 tons ; iron and steel and machinery, 1,125,740 tons ; raw material for metallurgical industries, 1,544,800 tons ; industrial products, largely chemical, 1,867,000 tons ; wood for fuel, 810,160 tons ; agricultural produce, 5,807,260 tons ; oil fuel, 2,224,500 tons ; various goods, 695,400 tons. Again, the geographical distribution of the waterways is indicated by the situations of the leading ports at Lille with a traffic of 470,890 tons in 1932, Strasbourg with 4,900,000 tons, Lyons with 1,369,000 tons, and Paris with 13,510,000 tons, excluding 3,271,000 tons in transit. The canals form three groups, all converging to Paris by way of the rivers Oise, Marne, and Seine. The group of northern canals joins the Oise near the junction of the river Aisne, and serves the coal basin of the Nord and Pas de Calais, with Douai, Lens, and Béthune, and the metallurgical and engineering centres of Lille and Valenciennes. From the south of Saint-Quentin the Somme canal branches off through Peronne, Amiens, and Abbeville to the small port of Valéry-sur-Somme. Between Lens and Lille there is another branch to Dunkirk, which is thus in communication with the entire northern system and with the Rhine at Strasbourg by way of the eastern section. The eastern group of canals joins the Marne and the Aisne to Paris, and covers a territory which is metallurgical in Lorraine (with the neighbouring iron ore mines of Briey), and industrial in Alsace. The port of Strasbourg opens the canals to traffic with the Rhine. The central group of canals extends from Roanne on the south to the Seine between Montereau and Melun, which is mainly agricultural country. Apart from these three systems, covering approximately a third of the country, there is a canal between Nantes and Brest and another between the Mediterranean and Bordeaux, comprising the Canal du Midi and a lateral canal along the Garonne to a point where the river is navigable. These canals are little used.

Traffic is concentrated mostly on the northern and eastern canals, and their grouping indicates that factors determining movements of traffic are :—International exchanges with Belgium and Holland ; local activities provided by the transport of coal and raw material to metallurgical and other industries within industrial areas ; the supply of Paris with a variety of bulky materials ; and the distribution of goods by a great international waterway like the Rhine. Canals serving mainly agricultural areas provide inadequate traffic. Their existence depends entirely upon bulky goods with a sufficiently long time limit for delivery. Conditions of economy vary with changes in railway rates, which, in France, have to be approved by the Government, and some time ago a railway company lost a considerable amount of oil traffic because it was not authorised to reduce rates in competition with freights offered on the waterways. Even under existing conditions railway competition restricts the economic range of water transport. Strasbourg imports cereals by the Rhine, and Havre receives wheat from across the Atlantic. The two ports are separated by 700 kiloms., but on account of the railway rates for cereals from Havre the port of Strasbourg cannot send wheat over more than 250 kiloms. of that distance. In the same way, Dunkirk wanted to secure some of the Alsatian potash and other traffic from Strasbourg which is being sent mainly by way of the Rhine to Rotterdam ; but the attempt failed because the canals, with their smaller



PRINCIPAL CANALS AND RIVERS OF FRANCE

boats and innumerable locks, could not compete with the river. Canals, while mostly serviceable and providing activity to inland ports, are, nevertheless, a charge on the nation, since the whole of the canal system, including sections that are hopelessly unremunerative, costs the State 120 million francs a year, with receipts amounting to between no more than 21 and 22 million francs.

During the years following the Armistice, an extension of the inland waterway system formed part of the scheme of national economic equipment. The first section of the Alsace Grand Canal between Huningue and Strasbourg, with the Kembs power station, was completed, and the utility of that short section for Rhine navigation is unquestioned. Another new canal, from Frouard, near Nancy, to Thionville, on the Moselle, has for its special object the transport of iron ore from the Briey mines to the Lorraine blast-furnaces, and of pig iron to the foundries. Its construction was also justified, but the experience of the Montbéliard-Haute-Saône canal revealed the limitations of inland waterways and their failure to create or divert traffic outside industrial areas. Those limitations are imposed by the tonnage of boats, slow transport, and interruptions to navigation. Generally, the draught of 5ft. 11in. allows the use of barges carrying loads of about 280 tons, which are insufficient for the economical transport of bulky goods of small value outside local areas. Hence the Office National de la Navigation is deepening the canals to provide a draught of 7ft. 4in. to enable loads to be increased to about 355 tons. This work has been completed between Lille and Anzin, but financial considerations have slowed down the deepening of canals and the lengthening of locks elsewhere.

Bigger loads and an acceleration of traffic are only possible with mechanical or electric haulage. The line of canals across the country from Dunkirk to Strasbourg has been equipped electrically, though not yet completed on the Est canals, and the current supplied by the Kembs power station and the electrical generating plants in the colliery areas brings down the cost of traction to an economical figure. The general extension of electric haulage, nevertheless, hangs upon the problem of how best to deal with the wide range of speeds between the small barge and the bigger oil-engined boat. Practically all barge owners, except those running motor barges, are grouped in a union wielding autocratic powers, whilst metallurgical and other companies possessing motor barges have their own association, which is growing in authority with the increasing number of motor barges in service. The Office National de la Navigation has so far failed to find means of conciliating the claims of these two groups. It can only see one solution of the difficulty, namely, a uniform speed that will allow traffic to be handled more smoothly and more efficiently, and it proposes to fix that speed at four miles an hour, which, with the inevitable delays at locks and ports, would mean that barges would travel about 15 miles a day. This confirms a regulation that was intended to give satisfaction to bargemen at the time of the strike the year before last, whereby motor barges are not allowed to go ahead of other boats or take precedence in passing through locks. Bargemen complain that this regulation is not enforced, which is possible, because owners of motor barges have as much right to the use of canals as those of hauled barges. The final result that should be achieved in order to obtain a maximum of canal efficiency would be the general adoption of motor boats travelling at the highest uniform speed compatible with the economical maintenance of canal banks. There are too many barges on the canals. No new barge can be put into service without scrapping an old one, and a motor barge must replace two hauled barges, so that the logical consequence of the general adoption of oil-engined boats carrying bigger loads would be a reduction of one-half in the number of boats and a higher uniform speed. The Office National de la Navigation cannot wait for this general transformation, which would entail a very long period of dislocated traffic. An organisation can only be effected under existing conditions, with mechanical and electric haulage, and a uniform speed for all boats limited by that of hauled barges would be a serious impediment to the progress of motor barges unless they were allowed to pass through locks before and after the eight hours' day of electric haulage. The Bargemen's Union strongly opposes this privilege being accorded to owners of motor barges. In the present phase of inland waterway organisation there is a tendency to generalise mechanical and electric haulage at a uniform speed and to leave motor traction to the rivers.

A drawback to canal transport is that navigation is not possible all the year round. The northern canals may be frozen in winter, sometimes for long periods, and during summer they may be deprived of water by drought, while further interruptions are caused by maintenance works. It follows that the certainty of canals being available for traffic does not exceed 250 days in the year. The sum total of days on which sections of the French canal system will be closed for repairs during the present year, in accordance with a programme arranged by the international commission in Brussels, is nearly 2200 ; that is to say, short sections will be closed for periods ranging from three days to two months. These conditions, and others of an economic character, limit the utility of canals to a particular traffic which could expand with an acceleration of speed, and a saving of time by improved facilities at ports, if the diversity of canal boats and a conflict of interest did not necessitate regulation of traffic. A further considerable gain could be made by night navigation, which is impracticable on canals, though advocated on rivers. Owners and navigation companies therefore experience competition for the more remunerative traffic from road lorries and railways, and the fall in canal freights has created a situation which compels the State to find a means of distributing traffic according to the facilities offered for handling it by canals, road, and rail. Each method of transport will be more or less specialised for particular requirements. Two commissions have long been engaged on this task at the Ministry of Public Works, one dealing with the relations between railways and road hauliers, the general lines of which have already been established, and the other with the distribution of traffic between the railways and inland waterways.

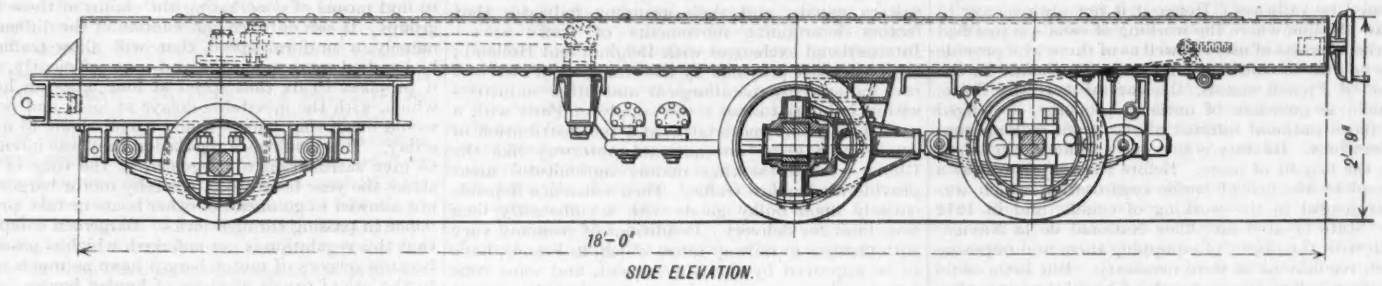
An important factor in the economy of inland waterway transport is the individual tonnage of barges. While the section of the canals over the greater part of the system restricts loads to less than 300 tons, they reach 2500 tons on the Rhine and 1200 tons on the Seine below Paris. The port of Strasbourg is a typical example of inland waterway traffic development between a great navigable river and the canal system. Its rapid rise began in 1926, two years after the promulgation of a law providing for an extension and equipment of the port and the creation of a new fleet of boats by the State. In 1930 the total traffic amounted to 5,750,000 tons, and, after declining heavily with the slump, it recovered in 1934 to 5,500,000 tons. Strasbourg imports mainly coal, cereals, and wood, and exports potash and iron ore.

The improvements to inland waterways have been accompanied by an increasing traffic to Paris, which is all one way, and barges and boats return mostly without freights. The traffic is now approximately 15,000,000 tons a year, and a programme for extending port facilities has been in course of execution for several years. A series of ports along the Seine and

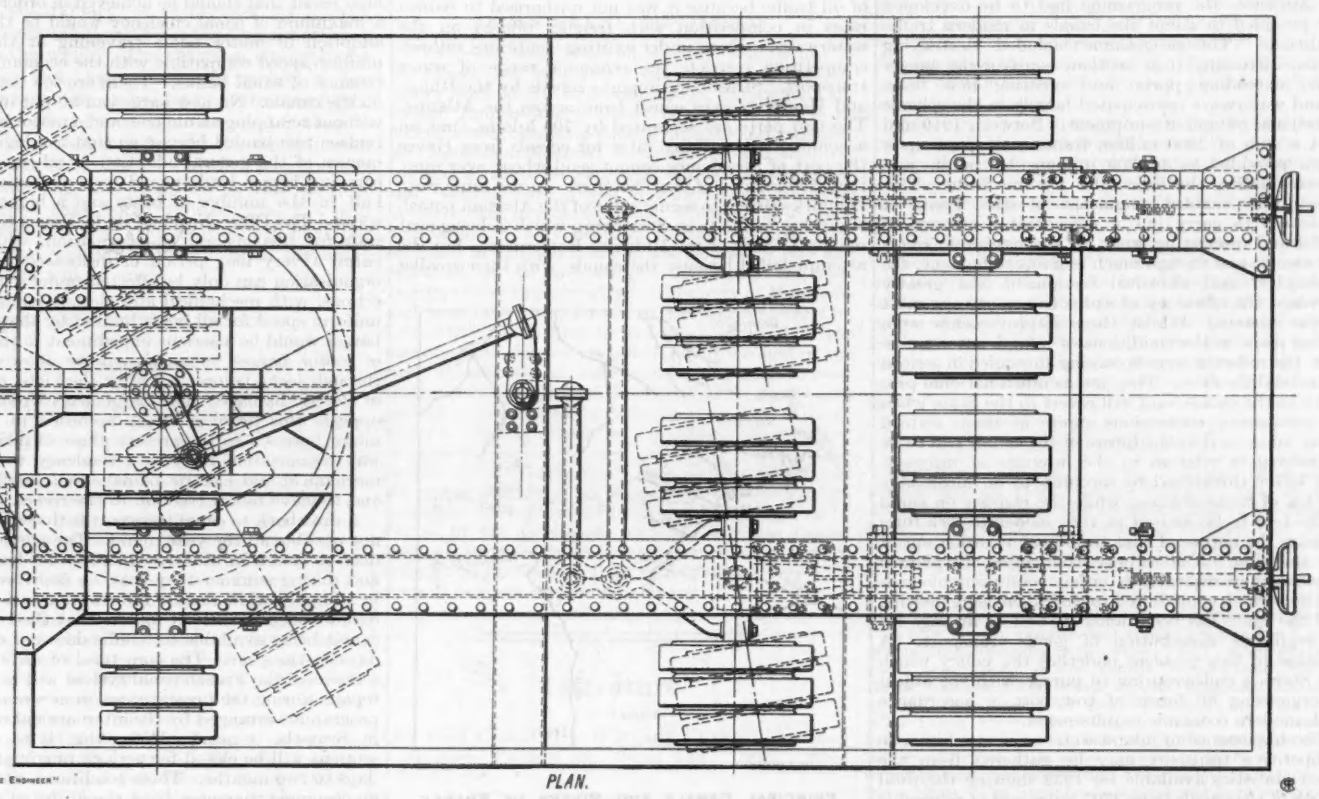
SIXTY-FIVE TON ROAD TRAILER

R. A. DYSON AND CO., LTD., LIVERPOOL, ENGINEERS

(For description see opposite page.)



SIDE ELEVATION.



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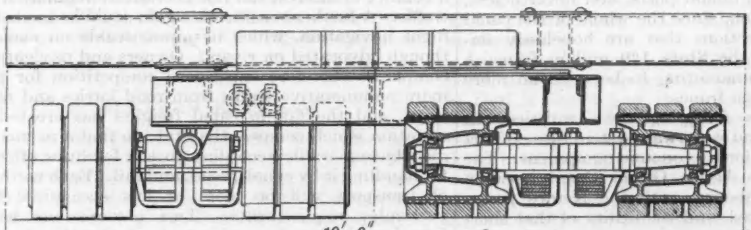

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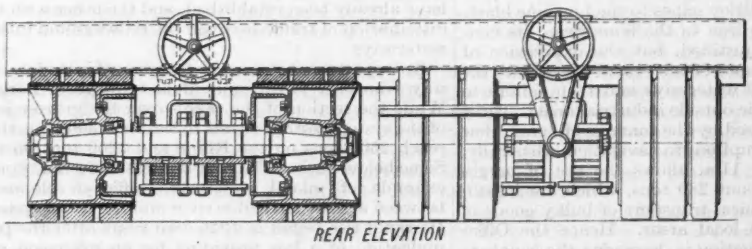
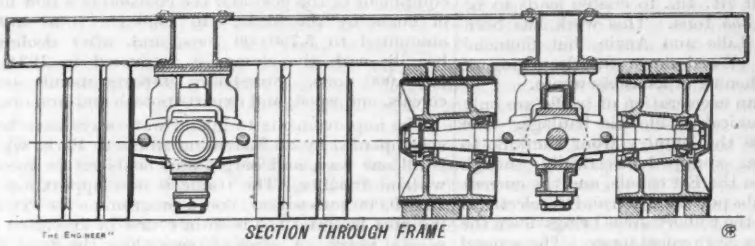
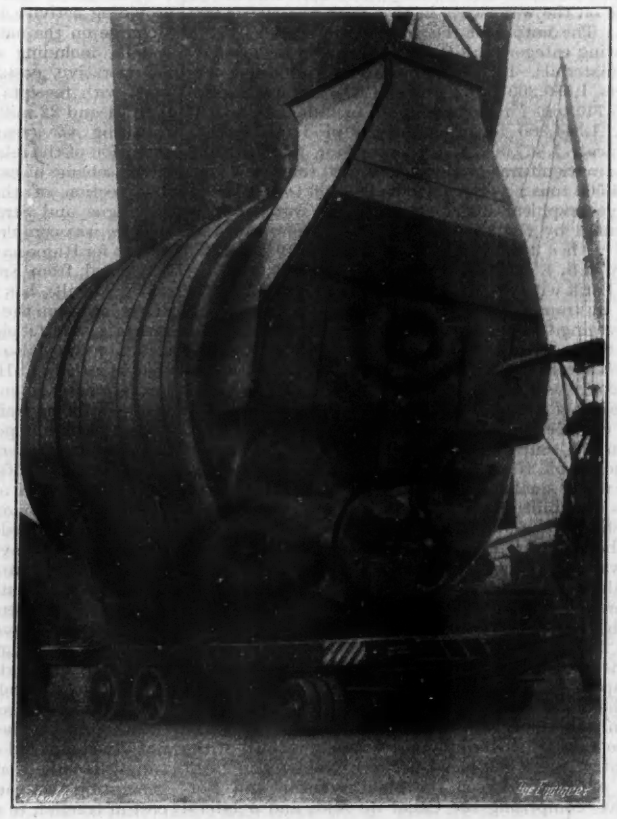


REAR ELEVATION



SECTION THROUGH FRAME



Marne and the Ourcq, St. Denis and St. Martin canals covers a total length of more than 62 miles. The Ponts et Chaussées have laid out a number of new small ports along the banks of the Seine in Paris, and boats of 1000 tons are able to traverse the city to Ivry. Outside Paris work is in progress on the construction of a port at Gennevilliers on 975 acres of land belonging to the Department of the Seine. The basins have a depth of 4·75 m. and will provide 7½ miles of wharves, with ample accommodation for warehouses. The port of Gennevilliers will deal with traffic between Paris and Rouen and also from the northern canals by way of the river Oise, which joins the Seine at Conflans. Within Paris the value of land will not allow of adequate means of storage, and goods, mainly coal, oil, and building materials, are usually brought from Rouen in 500-ton barges, but there are, nevertheless, services of boats carrying 1200 and 1500 tons. A limited traffic is still carried on between London and Paris. When the Gennevilliers port is completed it will doubtless be possible to augment considerably the services of big boats, and the programme now under execution by the Service des Ponts et Chaussées, which is responsible for the work and controls traffic on the Seine, aims at providing the maximum facilities for navigation. The Seine is not a deep river. It is maintained at a normal depth of 3·2 m. between Paris and Rouen by means of nine barrages and locks, and it will be eventually deepened to 5 m., although there is little prospect of that being done in the near future. The reconstruction of the barrages and locks at Suresnes and Chatou will be followed by the reconstruction of others with the idea of accelerating traffic through bigger locks and utilising the head of water at the barrages for the production of electrical energy. Whilst these improvements are being made old bridges that offer an impediment to traffic are being replaced by others. The most noteworthy of these new bridges are those of reinforced concrete at Saint Pierre de Vauvray and La Roche-Guyon, which span the river with ample clearance.

This equipment of the Seine between Paris and Rouen offers striking testimony to the skill and enterprise of the Ponts et Chaussées. At the same time, the sinuous character of the Seine detracts somewhat from the advantages of river transport and favours the use of bigger boats where possible. The distance between Paris and Rouen in a straight line is 68 miles and the length of the Seine between those cities is 150 miles, so that the time factor has an important bearing upon the development of traffic in competition with the railway. Nevertheless, economy favours the river where time is no object, and it is certain that navigation will be appreciably accelerated when the Service des Ponts et Chaussées has completed the vast programme it now has in hand.

A full and interesting account of all the inland waterways in France, comprising historical and technical reports prepared by the chief engineers of the different canal and river sections, has just been issued from the office of the Paris publication *Science et Industrie*.

A 65-Ton Road Trailer.

WITHIN recent times we have heard extensively of feats of road transport which have been entailed by the increasing bulk and weight of modern engineering products that have to be taken from their factory to the site of installation. These operations are, naturally, of a quite specialised character, and we have made brief reference to some of them. There are a few firms in this country which set themselves out to do this class of transport, but we would judge that Chas. D. Holmes and Co., Ltd., of Hull, are one of the few engineering concerns which possess, themselves, a road vehicle capable of taking a load of 65 tons.

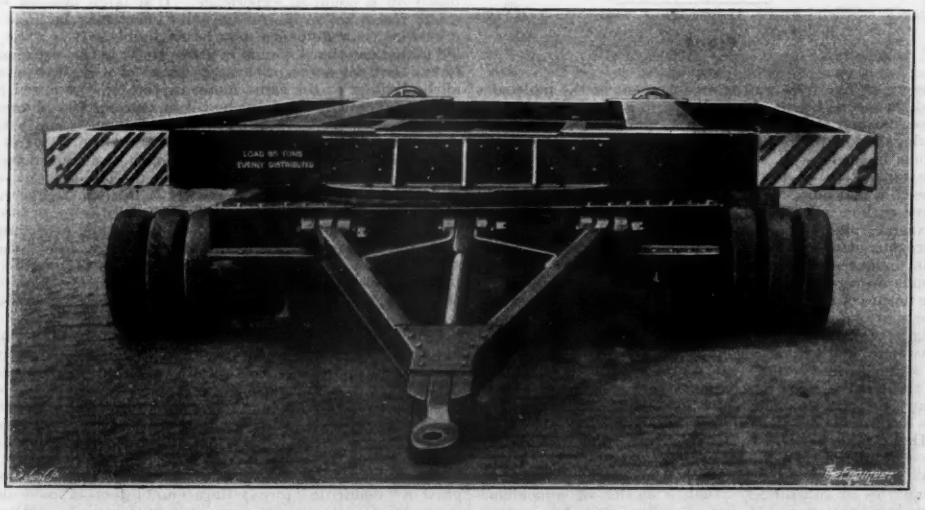
The Holmes works are situated some distance from the shipping basin and there has been a choice, in the past, of either dismantling the large pieces of machinery made there for piecemeal transport to the waterside, or using a cumbersome vehicle to which the Kingston-upon-Hull Corporation has taken exception on account of its effect on the roads. In the circumstances Messrs. Holmes arranged with R. A. Dyson and Co., Ltd., of Grafton-street, Liverpool, for the construction of a special trailer which would take loads up to 65 tons with facility and not damage the roads over which it passed.

The trailer appears, as seen in the half-tone engravings, to have three axles, but as a matter of fact it has six, as plainly shown in the drawing. On each side of the main framing there are three axles, each of which carries two wheels, so that there are in all twelve wheels, six of which are underneath the frame. Each of these wheels is equipped with three solid rubber Dunlop tires. The axles are all articulated and in this way the loading has been reduced to only 0·35 ton per inch of width of the tires. The wheels are 20in. in diameter and enable the loading height of the platform to be as low as 2ft. 8½in. The axles were machined from 40–45-ton Siemens-Martin mild steel.

A noteworthy feature about the vehicle is the fact that both the two front ranges of wheels are steerable. The four front wheels, on their two axles, are mounted on a turntable and there is a linkage connecting the table with the axles of the next set of wheels, which can easily be followed in the plan view, that makes these wheels track in behind the front wheels. The back wheels, naturally, follow behind and there is practically no side skidding when the trailer is turned through ordinary locks, with a corresponding reduction in the wear and tear of tires and road surface.

It will be noticed that the springs, made specially by Jonas Woodhead and Sons, of Leeds, are arranged towards the centre of each of the stub axles and that the axles are carried on trunnions, so that they will accommodate themselves to inequalities in the road surface. There is also a system of balance levers to distribute the load equally between the two sets of back wheels. The brakes are operated by hand wheels at the back of the vehicle and, in spite of the small size of the wheels, have drums 16in. in diameter with very wide shoes. The steel castings for the job were made by the National Steel Foundry Company, of Leven, Fife.

The principal members of the frame are two longitudinals, each built up of 8in. by 3in. channels, with 13in. by ½in. cover plates riveted on top and bottom. The overall length of the vehicle is 18ft. and its total weight about 7 tons.



FRONT VIEW OF TRAILER

Gear Finishing by Crossed Axes Shaving.*

IN a meeting of gear manufacturers, it is unnecessary to dwell on the difficulty of reproducing in steel the mathematics of gear design. Those of us with automotive experience, especially, are painfully aware of the great number of contingencies that are apt to rob us of our share of this life's tranquillity.

We know that no practical method of gear cutting can consistently produce a mathematically perfect product. The normal errors are tooth profile, index, excentricity, helical angle and tooth finish. Despite their microscopic order, however, these errors are apt to be serious, especially in a world which has suddenly become acutely conscious of gear noise.

The object of rotary crossed axes shaving, the subject of our present discussion, is the economical reduction of gear errors to a negligible value—this by correcting the proportions and finish of the gear teeth. The result is less gear noise, longer gear life, and more accurate mechanical operation.

One of the basic ideas behind this method of gear finishing is the crossing of the axes of cutter and work gear.

In crossed axes shaving the work gear is rotated under only slight pressure with a special cutter or tool in the form of a helical gear. The work gear and the cutter have different helical angles. The angle made by their axes in the machine set-up is equal to the difference in their helical angles, normally from 10 deg. to 15 deg., although this range may be extended on both sides of the limits given. The cutter is normally mounted with its centre over the intersection of the axes of the two shafts to assure correct tooth profile and helical angle in the gear being cut.

The relation of the axes compensates for the variation in sliding action due to the involute roll. As gear and cutter teeth are brought together cutting continues toward the pitch line up to the centre point, and in the reverse direction as they pass that point and separate. Thus uniform cutting is assured over the entire tooth profile.

Cutting can be rapidly increased by spreading the angle between the axes, but this tends to sacrifice guiding action and to reduce the width of the contact zone. Conversely, guiding action can be increased by reducing the angle between the axes, but this rapidly reduces the freedom of cutting until at a zero angle cutting is replaced entirely by a burnishing action.

A real value in crossing the axes is the limiting of the contact pressure required in cutting and the accurate guiding of the cutting edges of the gashed tool.

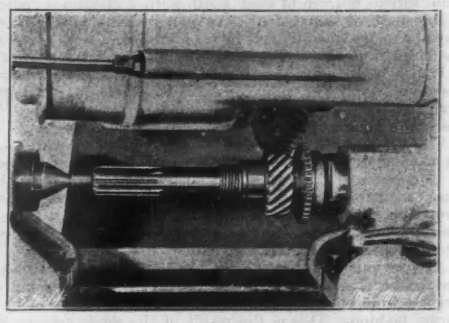


FIG. 1—WORK GEAR AND CUTTER

When two parallel cylinders of the same length are forced together, their contact surface is a rectangle, the length of which is the length of the cylinders and the width of which varies, of course, with their diameters, contact pressure, and elasticity. As the angle of these cylinders is increased from zero to 90 deg., the contact plane remains a parallelogram, but its area steadily diminishes to a minimum at 90 deg.

It is obvious also that as the angle between the axes is increased it will be necessary gradually to decrease the total pressure between the cylinders if the unit pressure on the plane of contact is to remain constant.

At a crossing angle of 10 deg. to 15 deg., the required cutting pressure is therefore only a small fraction of what it would have to be if the axes were parallel.

It is true that in the case of the cylinders above mentioned, the contact surface is parallel with the axes, while the actual contact of two mating gears is along the tooth profile in a plane more nearly vertical to the gear axes. That, however, does not change the working pressure relationship and its contingency on axial angularity. The pressure normally exerted between gear and cutter at a 10 deg. to 15 deg. angle is approximately 40 lb.

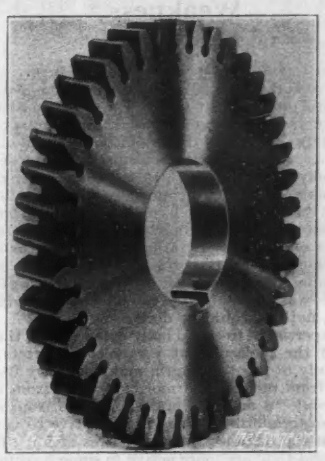


FIG. 2—THE GASHED SHAVING TOOL

The surface produced by the cutter on the work gear has minute lines travelling up the tooth from bottom to top. These indicate the spacing of the cross travel of the work per revolution. Inasmuch as the cutter contacts the work at a different point on each stroke, these lines are completely removed by one or more idling strokes after the actual cutting operation is completed. The final result is a smooth, mirror-like finish on the work gear tooth, but without the compression effect of heavy pressures. A gear tooth finished in this manner requires no additional processing.

The correct angularity between axes is accomplished in the machine head setting. In addition to the ordinary vernier scale for setting the head, an accurate indicator is also provided. This bears on a button, so that when the first sample gear is checked, any slight variation in angle can be corrected by revising the head setting.

The work gear mounted on live centres is driven and guided by the cutter. No other drive connection exists between them—Fig. 1. No dependence is placed on the accuracy of gear trains or other mechanical elements in this operation. The profile of the gear, its angle, index, and excentricity are determined solely by similar functions of the cutter itself.

At the end of each table stroke, the direction of cutter

*From an address by Mr. R. S. Drummond at the recent meeting of the American Gear Manufacturers Association.—*Iron Age.*

rotation is reversed. This assures similar characteristics in the profile of each side of each tooth.

Cutter speeds are considerably higher than might normally be expected. In many cases cutters are run at 400 surface feet per minute.

The rough gashing of a gear invariably leaves certain cutting strains in the surface of the gear teeth. These strains, relieved in the heat-treating operation, are often responsible for final distortions which appear as errors in the finished gear. It is important to know, however, that the shaving process, with the gear operating at high speed and light contact pressure, almost completely eliminates these initial cutting strains. Minute, hair-like shavings are taken from the gear tooth surfaces in a manner much the same as that effected by a fly cutting tool. Obviously the finer the cuts made, the less pressure is required between cutter and work.

Cutter Error Within 0·0003in.

The tool itself—Fig. 2—looks like a normal helical gear gashed at right angles with its axis. The gashes extend from top to bottom of each tooth with a clearance space at the base of the tooth. This tooth base clearance not only provides unrestricted flow of lubricant to wash out the chips, but also facilitates the gashing operation itself.

It has been found possible to produce cutters with an accumulative error not to exceed 0·0003in. Present practice is the result of an extensive programme of research and is fully covered by patents.

The life of a cutting tool is unusually high. Normally, from 6000 to 12,000 work pieces can be produced before it is necessary to regrind the cutter. In normal pitch sizes, a cutter may be reground a number of times. In five-pitch cutters, seven to ten regrinds are practicable, thus making a total of 42,000 to 100,000 work pieces per tool.

As previously stated, chips shaved off the gear tooth surface are hair-like in dimensions. They are normally twisted from end to end instead of being coiled in clock-spring fashion. This is the result of the angle setting of the axes of cutter and gear.

The prompt evacuation of these hair-like chips presented a problem in the development of this machine. Being so light, the chips are easily carried in suspension by the cutting lubricant. Consequently, a very careful straining of the lubricant is necessary to prevent chip return to the cutter faces. A continuous flow of lubricant is provided on both sides of the cutter contact in order rapidly to wash out all chips immediately after they are formed. A relatively high oil pressure is used for this purpose.

A practical limitation on crossed axes shaving occurs with shoulder gears of different diameters and in close proximity. Lack of space between the individual gears obviously limits the angle at which the axes may be crossed. With a space between gears of ¼in. and with differences in diameter of 1in. or more, cutting can be accurately done.

Each case in this category must be studied individually to determine the most practical axis angularity.

The Theoretical Strength of Materials and their Practical Weakness.*

By Sir WILLIAM BRAGG.

If I am to fulfil the promise implied in my choice of a title for this discourse, I must in the first place describe the grounds on which, it is claimed, a calculation of the strength of materials can be based, and then proceed to show that practice falls disappointingly short of theory, with reasons, so far as they can be given, for the deficiency.

It is only lately that calculations of strength have been possible. It has, of course, been known for a long time that the forces which make the solid body hold together must be due to the conjoint action of the forces exerted on one another by atoms and molecules of which a body is composed. But so long as there were no means of examining fine details of the composition of a solid, and there was consequently no exact knowledge of its structure, nothing could be done.

The properties of the solid body depend upon the mutual actions of the molecules at very close quarters. These are certainly of great strength, and they vary from atom to atom, from molecule to molecule, even from one part of a molecule to another, and sometimes from one part of an atom to another. They are sensitive to very slight changes in the distances of the centres of force from one another, and they are more active in some directions than in others. Clearly there is little that can be done to solve the problems of cohesion until the details of all these actions are known, and it is because the knowledge has not been available that the laws of the solid have not been discovered or even open to investigation, as have, to some extent at least, those of the gas and liquid.

In the last twenty years the situation has been entirely transformed. To begin with, the X-rays have provided us with a means of distinguishing the atoms and molecules of the solid, not individually, indeed, but when they are arranged in the regular array of the crystal, as is so often the case. We can now discover the structure of a crystal and the arrangement of the atoms in the unit of pattern by the regular repetition of which the crystal is built up. And since all solid bodies are crystalline in whole or in part, or at least tend to be crystalline, our new powers extend over the whole of the solid range. It is sufficient to find the projection of the electron densities upon one or two of the important planes of the crystal. We obtain a picture which resembles what we should see if we looked through a vessel of the size and form of the unit cell, the vessel containing a transparent liquid in which various clouds were suspended. Each cloud would represent an atom; its density would be greatest at the centre and would diminish towards the edges, fading away into the transparency of the liquid. Sometimes clouds must overlap because atoms stand in front of one another. Sometimes one point of view is better than another, and it may happen that from all points of view an atom is difficult to disentangle. But in general, as the result of a considerable quantity of arithmetical calculations, we obtain projection pictures which give us a remarkably clear picture of the relative positions of the atoms of the cell, and enable us to measure distances and angles with accuracies of 1 or 2 per cent.; sometimes we can do better than that.

It is astonishing to think of the possibilities this new knowledge is opening out to the physicist, chemist, biologist, and, indeed, to every student of science. It is a new field of research, undreamt of not long ago. The very idea of being able to consider the properties of the individual atom was rejected in comparatively recent times by many well-known men. At a recent conference in Bonn the President, Herr Walden-Rostock, quoted an exclamation of Schönbein's, seventy years ago: "Geht mer weg mit Eure Atome, warum gibt's nit Atome so gross wie die Leberklöss, dass mer se de Leit weise kann?" ("Get away with your atoms! Why aren't they as big as liver dumplings so that people can see them?")

When we realise that cohesion can be ascribed to electric action, we need have no fear lest we should not have sufficient explanation of its strength. Indeed, that is really the question which I am asking you to consider. Why, if the forces are so great, are bodies not stronger than we find them to be?

Let me take researches which have been carried out in the Davy Faraday Laboratory within the last few months. One deals with the structure of a remarkable substance synthesised at the Woolwich Research Laboratories, and known as cyanuric triazide. It is very liable to explosion and has, indeed to be handled in small quantities and with great care. Fortunately, it is possible to carry out the X-ray analysis with a crystal weighing one-tenth of a milligram. The molecule contains three carbon and twelve nitrogen atoms. The absence of hydrogen atoms is a welcome feature, as their lightness makes them difficult to place by the X-ray methods. Chemical analysis shows that the three carbons and three of the nitrogens are placed at the corners of a hexagon and that three other nitrogens are attached to each carbon. These latter groups of three nitrogens each are known as tri-azide combinations. There has been argument as to the arrangement of the triazide group, but chemical opinion seems to have settled down lately in favour of a linear arrangement. This is confirmed by the X-ray results, as shown in Fig. 1.

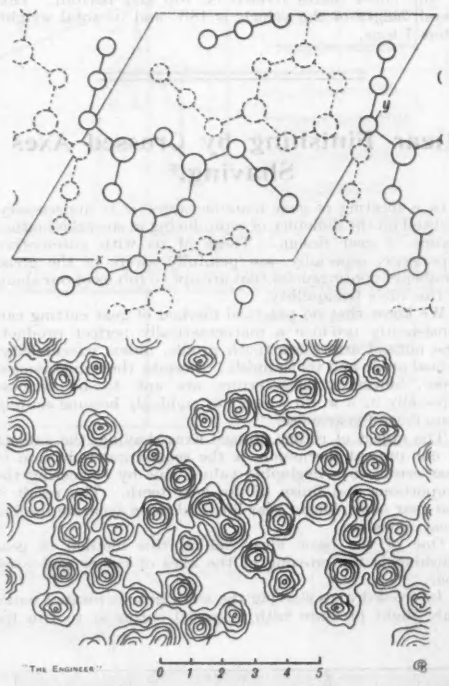


FIG. 1

The upper figure shows the arrangement of the molecules and their constituent atoms drawn in agreement with the chemical and the X-ray evidence, while the lower figure is the shadow picture of electron density. The lie of the atoms is easily seen. A picture like this is very nearly the realisation of the chemist's dream, that he might "see" a molecule. We see the ring of three nitrogen and three carbon atoms, and observe that it is not a perfect hexagon; its symmetry is trigonal only. The three nitrogens attached to each carbon are accurately in line. The distances that separate the centres of the nitrogen clouds are in harmony with the chemical evidence as to the nature of the bonds. The triple bond at the end of the line is drawn more tightly than any other in the molecule (Fig. 2), the double bond is next, and the single bond between the third nitrogen of the line and the carbon to which it is attached is the longest. As for the lengths of the links within the chain, three appear to be longer than the other three, which should not be surprising as the molecule is trigonal and not hexagonal.

Determinations of structure serve to show how closely we can match the determinations made by the X-ray and other new methods with the previously known properties of substances. Such a wealth of coincidence and explanation could not be sustained by a false hypothesis.

Suppose now that a salt crystal is ruptured by tension. The pull is applied in a direction parallel to one edge and breaks simultaneously at all points on a plane perpendicular to the line of pull. On certain assumptions, which are clearly reasonable, it is possible to calculate the force which must be applied to overcome the electrical attractions between the positives and negatives on one side of the plane of rupture, and the negatives and positives that intially faced them across the plane. It turns out to be about 200 kilogs. per square millimetre. If, however, we make the experiment we find that the rocksalt generally gives way for a pull of less than 1 kilog. Sometimes it can be more, even much more. The strength of rocksalt is greatly increased, for example, if it is tested under water, and it is affected strongly by the nature of the vapour which surrounds it. Other substances behave in the same way. What then is the reason of this defect? It is, of course, a matter of some concern to us because the materials which we handle might conceivably, under proper conditions, be far stronger than they are, and there might be a very great economy in the weight of constructions.

The problem very naturally presented itself as one of importance to a reseach worker in the Royal Aircraft Establishment at Farnborough, where the design of aeroplanes called for every possible economy in weight consistent with strength. This was Dr. A. A. Griffith, who suggested that the defect in strength was due to flaws or cracks, especially such as lie on the surface of the piece under stress. It may seem an obvious kind of suggestion, but it is to be observed that, in the first place, if there are such flaws they cannot be seen under the microscope, nor can they be detected by the X-ray methods. They are too small for the one means of examination and too large for the other. In the second place, it is very difficult to account for their existence. Their amount seems to depend on the previous history of the crystal, its treatment during formation from solution, or crystallisation from the melt. There are other properties which depend in the same way on the manner of growth, such, for example, as electrical conductivity, and fluorescence under radiation, so that crystals may differ widely in respect to these matters, and yet are shown by X-ray and other methods to be of exactly the same structure. Also some of these properties are greatly affected by treatment after formation. The "hardening" of certain metals and alloys by cold working is a well-known effect of great industrial importance.

There is, therefore, some characteristic of materials which causes their properties to vary although their structure, as revealed by X-rays, is perfectly constant. These properties have been named "sensitive properties" by Smekal, who has studied them with great care; they are sensitive to the previous history and treatment of the crystal, while other properties, such as the fine details of structure, are unaffected and "insensitive."

When this characteristic is fully understood there will be at the same time an understanding of hardening by cold working, and the rest of the sensitive properties. It is something which the X-rays do not detect, and it will probably be in accord with Griffith's hypothesis,

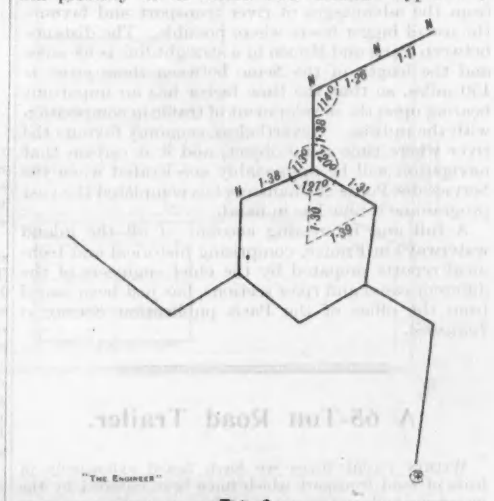


FIG. 2

which, indeed, is generally held to be correct in its essence.

The explanation suggested by Griffith is in reality based on a common experience. If a large number of small forces act in unison the joint effect may be great; otherwise their influence may be negligible. It is a very old statement that "Union is Strength." If the electrical forces that act across a cleavage plane of a crystal must all be broken at the same moment, the force required is very great, but if they can be taken more or less in turn the task is at any moment easier, though it takes longer to carry out. When the opposing faces are withdrawn from each other by far less than the millionth of a centimetre, the attraction has practically vanished. The amount of the force as calculated is far greater than that discovered in practice because all the electrical forces are supposed to be broken at the same moment, and this, according to Griffith, does not happen. If there is a crack, the stress that should have been borne by the parts separated by the crack is shifted on to the material at the edge of the crack, which thereby experiences an excessive stress which it cannot resist, and so the crack widens.

Griffith's theory supposes that the crystal cannot put out its full resistance to rupture because it is not perfectly uniform and flawless. The question then arises as to the origin of these flaws, and here there is divided opinion. Some have imagined a superstructure in the crystal, so that planes at regular intervals are weaker or, at any rate, different from the rest. But this conception lacks experimental and also theoretical support. A very interesting suggestion is based on the fact that crystals often grow in "dendritic" form: the accumulations of molecule to molecule stretch out into the surrounding, mother liquor, like trees with boughs and subsidiary branches. Eventually the empty spaces are all filled up, and the joins may be supposed to be sufficiently imperfect to have the same effect as actual cracks. It might be that the atoms themselves, as they draw closer together when the temperature falls, find that the first arrangement into which they were cast when their motions were considerable is no longer free from stress when their mutual and local influences can make themselves felt, and the effort to release themselves from strain may cause the

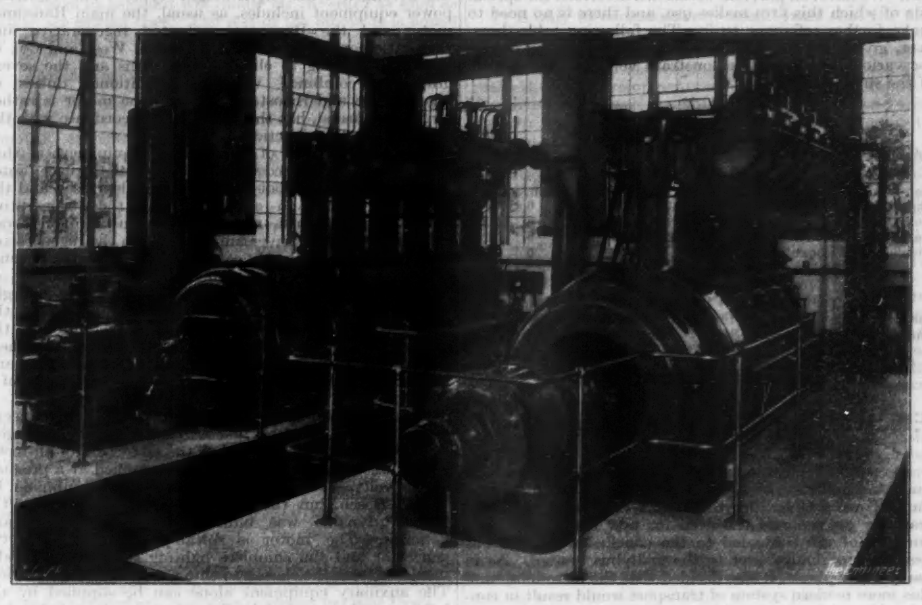
* Abstract of a lecture before the Society of Engineers, April 3rd, 1935.

appearance of discontinuities which act as flaws. Added to this uncertainty as to the origin of the flaws is a serious ignorance of the explanation of the effects of hard working. A rod of copper ½in. in diameter can be bent with the greatest ease, if it consists of a single crystal. But after it has been bent and unbent once or twice, the single crystal is broken up into many smaller crystals and now a strong man cannot bend it. Professor G. I. Taylor has alone offered a reasoned explanation of the effect, and these mysterious cracks are necessary to his calculations.

To sum up, new knowledge respecting the form and structure of molecules and their arrangement in the solid has poured forth in a flood during the last twenty years. It has provided the most interesting explanation of well-known phenomena, and this is obviously no more than an indication of what is coming. And while in so many ways it is satisfactorily linked up with experience, in others there are problems yet unsolved. The X-ray and other methods to which I have referred give a clear picture of the fine details of the crystalline structures which are the fundamentals of the solid. There is clearly a coarser structure which these methods do not touch directly. It may be regular or irregular; it may be more or less associated with some atomic property which we do not yet appreciate, or it may be quite accidental. There can be no doubt of its importance because we have so much to learn yet of the larger details of the materials which we handle and use in our constructions. Still more intricate and fascinating are the similar problems of the living organism.

West Kent Sludge Digestion Works.

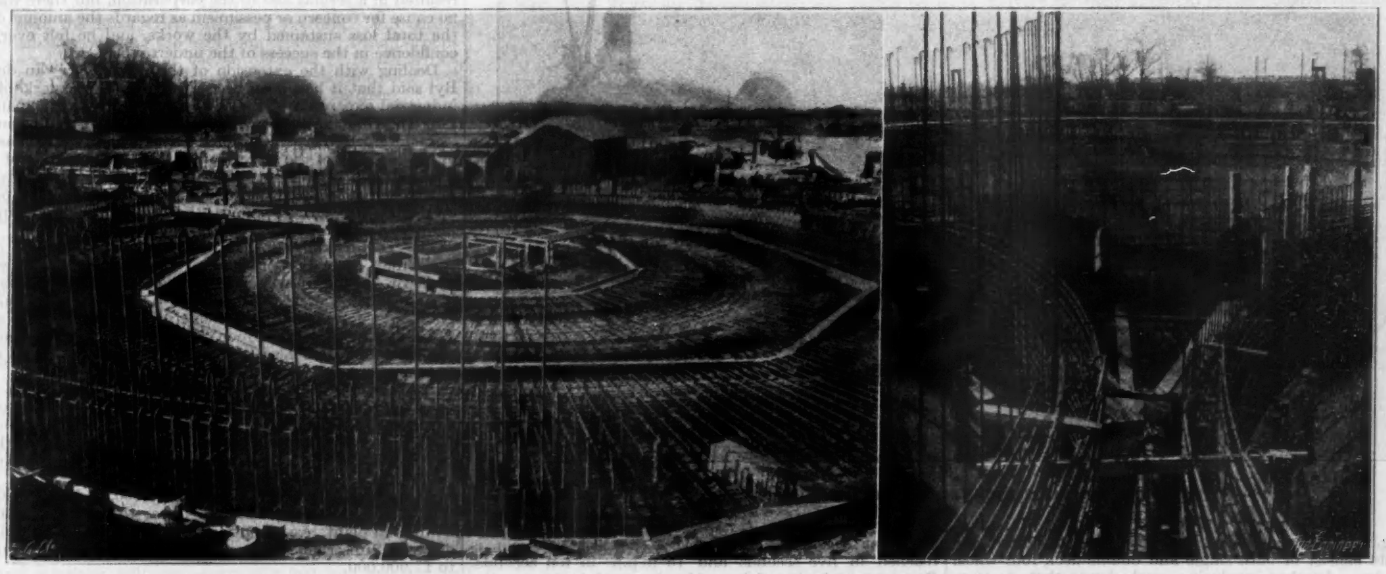
AT Dartford recently an interesting extension to the West Kent Main Sewerage Board's works was inaugurated by Alderman R. W. James, Chairman of the Board. It was in 1928 that the disposal of sludge began to become a serious problem, owing to the great increase in population of the large area served by the Board. Consideration was therefore given to the practicability of dealing with the sewage by a process of digestion. Experiments were carried out at the works to discover whether the sludge was amenable to digestion and what advantages might be derived from the process. It is claimed for the process that the sludge discharged to the beds after digestion will not cause any aerial nuisance, and that it is greatly reduced in bulk, and will dry more rapidly; that gas given off in the process of digestion has a higher calorific value than coal gas, and can therefore be used for the generation of power; and that all seeds, except perhaps those of tomatoes, are destroyed, so that after drying and disintegration the sludge can be used as a valuable fertiliser for agricultural processes. Following upon the experiments, certain members of the Board paid a visit to certain works in Germany, where the process could be seen in operation, with the result that it was decided to adopt the Prüss process. Certain difficulties having arisen in Germany, however, not with the process, but in other ways, it was impossible to proceed with the arrangements that had been made, and attention was given to alternative proposals, such as the carrying of the sludge to sea. Finally, however, after a number of large cities had been consulted as to its merits, the Dorr-Oliver process of sludge digestion was adopted, and orders were given for three digestion tanks of a total effective capacity of 450,000 cubic feet.



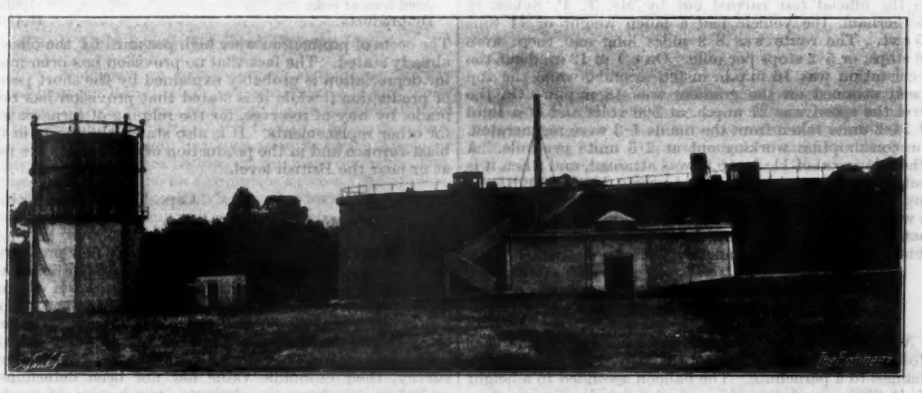
NATIONAL SLUDGE-GAS ENGINES IN POWER-HOUSE

Digesting Tanks.

Each digester consists of a reinforced concrete tank, 85ft. in diameter and 29ft. deep, with a practically flat bottom. Two sets of slowly rotating arms mounted on a vertical axis are driven by a 3 h.p. motor. One set of arms is situated near the roof and the other just clear of the floor. As the raw sludge is fed in daily from the top, the upper arms serve to spread it and also to break through the layer of scum that otherwise tends to form, and to prevent the escape of gas. The lower arms have plough-like projections, which feed the digested sludge towards the central outlet at the bottom of the tank. During digestion the organic matter in the raw sludge is acted upon by bacteria and more than half of it is converted into methane and carbon dioxide, a certain amount of liquefaction taking place. At the same time the specific gravity of the solids is on the increase, a fact which causes the sludge to feed automatically towards the bottom of the tank as the digestion proceeds. The rate of decomposition by this process is much hastened by maintaining the sludge at a temperature of about 80 deg. Fah., and for this purpose heating coils are built into each digester, through which hot water is pumped from a multi-tubular Cochran boiler in the nearby boiler-house. The rate of flow is regulated by thermo-control valves. To prevent heat losses, the roofs and sides of the digesters have been covered by slabs of sheet cork, 2in. in thickness, set in hot bitumen, and finally covered with a coat of emulsified asphalt. The digested sludge is discharged to drying beds, where it is reduced to about 45 per cent. moisture, and it is then conveyed to a building where it is disintegrated and bagged for sale as a fertiliser.



REINFORCED CONCRETE DIGESTING TANK UNDER CONSTRUCTION



DIGESTING TANKS AND GAS HOLDER

The gases evolved during the process of digestion, as shown by analyses taken at the West Kent works, have the following composition :—

Carbon dioxide	25·4
Oxygen	0·1
Methane	66·8
Hydrogen	6·9
Nitrogen	0·8
	100·0

The calculated calorific value is 715 B.Th.U. per cubic foot. This gas is collected in a gas dome, situated near the centre of the roof of each digester, and led through suitable pipes, moisture traps, relief traps, and meters to a gasholder with a capacity of 20,000 cubic feet, at a pressure of 6¼in. The gasholder serves the boiler-house and two National sludge-gas engines in the power-house. The latter, each of which has five cylinders and runs at 375 r.p.m., are direct-coupled to 172-kW Lancashire Dynamo alternators, generating current at 400 volts, three-phase, 50 cycles. This equipment provides power for lighting the works, and driving the various pumps and other mechanisms. There is left over a large surplus of gas, even in winter working, when the boiler requires nearly twice as much as in summer.

A number of photographs are reproduced with this article, showing the digester tanks and other buildings under construction. Their erection, which was carried

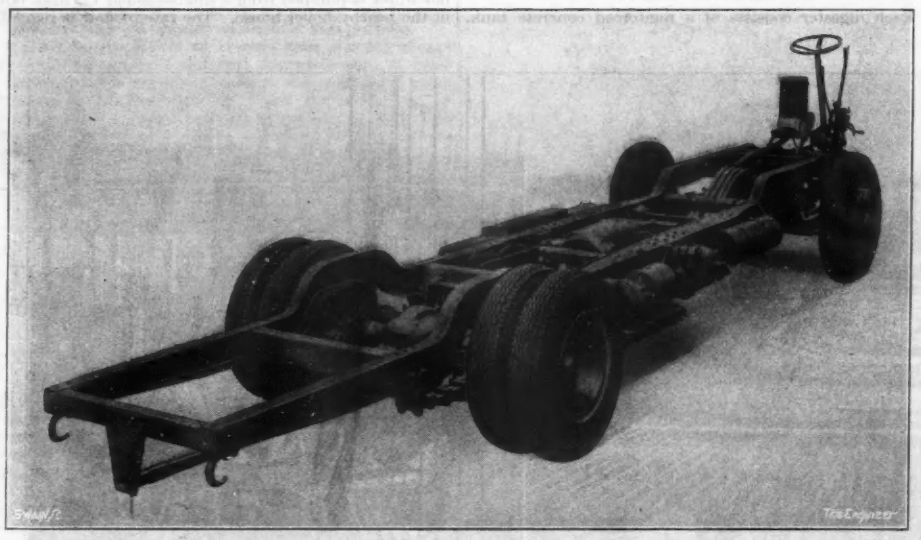
out by A. Jackaman and Son, Ltd., was beset with difficulties, owing to the treacherous and varying nature of the subsoil. After very careful investigation of these conditions, it was decided to give the contract for the piling foundations for the digesters and the other buildings to West's Rotinoff Piling and Construction Company, Ltd. We have, on previous occasions, described the special pile of which this firm makes use, and there is no need to make further reference to it. The following table, however, giving the maximum and minimum lengths of pile for various loads, will demonstrate very well the nature of the subsoil :

	No.	Length. Min.	Length. Max.	Load per pile.
		Ft. in.	Ft. in.	Tons.
Digesters and boiler-house ..	660	17 0	47 6	40
Power-house	31	13 0	19 6	45
Gasholder	24	22 9	43 6	32
Purifiers and booster house ..	8	34 3	40 0	6

That the plant installed has operated with satisfaction may be judged from the fact that three more digesters are shortly to be constructed.

Electric Trollybuses for Cape Town.

A FLEET of electric trollybuses, built by Ransomes, Sims and Jefferies, of Ipswich, will shortly be running in Cape Town. Operating difficulties associated with the tramway system and the need for new track on certain portions of the route led to the conclusion that it was desirable to change over to the trollybus system. As in many other places, it was decided that the introduction of this more modern system of transport would result in considerable advantages. Apart from saving the cost of renewing old portions of the track, it will simplify operation and the public will enjoy faster and more comfortable transport. In consequence of visits paid to this country by the Cape Town tramways general manager, Mr. W. F. Long, it was decided that the initial fleet of trollybuses should consist of both single and double-deck four-wheel vehicles. Another conclusion reached was that, in view of the severe gradients on certain routes, it was desirable in order to reduce current consumption and brake maintenance, to utilise regenerative braking. Regenerative and rheostatic control gear designed in accordance with the Ransomes patented system has therefore been adopted. The Ransomes-Garrett patented telescopic transmission shaft is also employed. A sample vehicle had to pass a road test under the official inspector, Mr. T. P. Sykes, the general manager of the Rotherham transport undertaking.



CHASSIS OF ELECTRIC TROLLYBUS FOR CAPE TOWN

Of the fifty vehicles ordered thirty are double-deck buses designed to seat sixty-two passengers, whilst the remainder are of the single-deck type to seat 39 passengers, the chassis, as exemplified in the accompanying illustration, being substantially the same in both cases. The all-metal bodies, constructed by Weymann's Motor Bodies (1925), Ltd., of Addlestone Works, Surrey, comply with the British Ministry of Transport requirements. Considerable improvements have, however, been effected in the way of dimensions, as the result of certain concessions made by the Ministry. The length of the vehicles is 27ft. 6in. and the width 7ft. 10½in. By permitting a slightly smaller ground clearance than usual it has been possible to provide a practically straight line transmission. The vehicles are constructed to be capable of turning between kerbs 52ft. apart.

The chassis frame conforms generally with the Ransomes standard design and is constructed of high-tensile steel sections stoutly braced by cross members composed of similar sections. The motor is mounted amidships and, in addition to permitting of a practically straight line transmission, it contributes to the rigidity of the structure. The Kirkstall Forge latest design of back axle embodies worm reduction gear and a differential, the drive being transmitted by the Ransomes-Garrett patented floating tubular propeller shaft. Internal expanding brakes act on the front and rear wheels. The G. D. Peters air braking equipment consists of a Reavell compressor driven by a Ransomes motor, both mounted on an insulated bedplate. Brake adjustments can be made in a few moments without the use of spanners or other tools. Lubrication of the chassis is carried out in accordance with the Tecalemit grouped nipple system.

After much consideration the Cape Town authorities decided to use a current collecting shoe instead of a trolley wheel and the collecting gear employed is of the Brecknell Willis light-weight type. The electrical power equipment includes, as usual, the main Ransomes motor and the Ransomes patented regenerative and rheostatic control gear made by Allen, West and Co., of Brighton. Owing to climatic conditions and the severe gradients, combined with the additional duties of regenerative and rheostatic braking, the motor is rather larger than usual, but the design is in accordance with the makers' standard practice.

A special feature of the control equipment is that regenerative and rheostatic braking takes place automatically when the foot brake pedal is depressed and the driver is unable to avoid utilising the regenerative characteristics whilst normal operation is in no way impaired. Even a driver unfamiliar with the regenerative principle is unconsciously compelled to obtain the benefits of the system, since the vehicle cannot be retarded or brought to rest without electric braking being brought into action. The Allen-West control equipment is of the contactor type with the contactor panels mounted on the side members of the chassis. Besides the control gear there are wireless anti-interference coils, lightning arresters, and indicators which give visible and audible indication of a dewirement.

It is well known that on vehicles of this type special precautions have to be taken to ensure that passengers shall not receive shocks, and as the bodies are of all-metal construction the lighting current is supplied at a pressure of 24 volts. The lighting equipment was supplied by C.A.V. Bosch, but the 500-volt motor which drives the 24-volt dynamo was built by Ransomes, Sims and Jefferies. The motor is suitably insulated from the generator and the complete lighting set is mechanically insulated from the chassis to eliminate noise and vibration. The auxiliary equipment alone can be supplied by the battery and immediately the internal saloon lighting is switched on the motor generator comes into action.

Standard tests made at Ipswich have shown that a fully loaded single-deck vehicle accelerates to 10 m.p.h. in four seconds and to 20 m.p.h. in fifteen seconds, while when ascending a gradient of 1 in 12 a speed of 10 m.p.h. is reached in five seconds and 15 m.p.h. in ten seconds. Regenerative braking followed by rheostatic braking on the level reduces the speed from 26 m.p.h. to 10 m.p.h. in five seconds and to 5 m.p.h. in seven seconds. When descending a 1 in 12 gradient a fully loaded vehicle can be held at 12 m.p.h. by the regenerative brake and at 2 m.p.h. with the rheostatic brake. Readings taken on a Tapley meter showed that when the mechanical and electrical braking were applied simultaneously a retardation of 15·5ft. per second was obtained, whilst if the hand brake was also applied the retardation was 18·5ft. per second. In the official test carried out by Mr. T. P. Sykes, of Rotherham, the vehicle had a laden weight of 11 tons 15 cwt. The route was 8·9 miles long and there were 46 stops, or 5·2 stops per mile. On a 1 in 12 gradient the acceleration was 16 m.p.h. in ten seconds, while the top speed attained on the gradient was 18 m.p.h. On the level the speed was 27 m.p.h. at 500 volts and of a total of 24·2 units taken from the mains 4·3 were regenerated, the consumption working out at 2·3 units per mile. A schedule speed of 11·4 m.p.h. was attained, and when it is stated that the vehicle weighed nearly 12 tons and for a large part of the journey it was negotiating severe gradients, it will be realised that the results are in every way satisfactory, especially as the driver made no attempt to obtain the maximum regenerative effect.

A SUCCESSFUL experimental flight has been made near Moscow with a new type of balloon which in mid-air changes to a parachute. The balloon ascended to a height of 16,650ft., and the sides of the envelope were then slowly opened out like an umbrella. Simultaneously extra material forming the bottom of the bag was pulled up on a hard rubber shaft towards the top of the bag. The gas was thus prevented from escaping while the balloon was changing shape. As it changed shape the balloon began to descend, but at a speed which never exceeded safe limits.

South African Engineering Notes.

(By our South African Correspondent.)

CAPE TOWN, July 5th.

Pretoria Steel Works.

IN an address to the shareholders of the South African Iron and Steel Industrial Corporation, Ltd., of Pretoria, at the annual general meeting on Friday, June 28th, Dr. H. J. van der Byl, the chairman, was able to review for the first time since the inauguration of the company a period of production. He quoted figures showing that this first period, ended December 31st, 1934, had closed with a loss of £266,022. This loss, Dr. van der Byl explained, was small when the scale of operations and the difficulties encountered were taken into consideration. In addition, a considerable portion of the loss was incurred before the whole of the plant was fully operating, and could therefore be allocated to starting expenses, and as such debited to capital account. If that had been done, he said, the loss would have been reduced, but the directors preferred not to burden the capital account in that way. For the first quarter of the present year, however, a small profit had been shown after provision was made for debenture interest and reserves.

Dr. van der Byl stated that a certain amount of revenue was derived from the coke ovens, the blast-furnace, and steel-melting departments—*i.e.*, from the sale of coke and by-products, pig iron, and steel ingots respectively. The main revenue-producing departments, however, were the rolling mills and steel works.

It would therefore be apparent, first, that quite apart from restrictions in output due to starting-up difficulties, normal conditions of production could not be reached until the whole works were functioning as a complete unit; and, secondly, that only two of the three main revenue-producing departments were in operation during 1934, and these only for a part of the year. Other reasons were the change over from construction to production, the recruiting of a large executive and operative staff, and high unit costs on account of restricted production. The total revenue up to December, 1934, was £528,786. There was no need, said Dr. van der Byl, to import road materials while Iscor (the name given to the Pretoria works and company) could supply them at competitive prices, and he recommended the Corporation's tar, of which 1,750,000 gallons were produced annually, and he defended the selling of coke by the corporation in competition with Natal coke. The change of railway tariff in 1931 had resulted in a serious loss to the corporation, but there was no cause for concern or pessimism as regards the amount of the total loss sustained by the works, and he felt every confidence in the success of the undertaking.

Dealing with the extension of the works, Dr. van der Byl said that it had been necessitated by the remarkable industrial expansion of the Witwatersrand. That expansion could not have been foreseen. The main extensions were the erection of an additional blast-furnace, the increase of the capacity of the heavy rolling mills, the erection of a foundry, and a plate mill, the installation of an inactive mixer in the melting shop, and additional soaking pit and reheating furnaces, and other additional producing plant to provide for new classes of business, &c.

The meeting was informed of the improved position of the Union Steel Corporation—a concern now controlled by Iscor—owing to increased turnover. Negotiations had been concluded with a Canadian firm—MacKinnon Chain Company—for the establishment of a chain factory at Vereeniging, where the Union Steel Corporation works are situated. Iscor is also now making bolts and nuts in co-operation with Guest, Keen and Nettlefolds.

A company—the Steel Sales Company of South Africa—has been formed to assist in the disposal of the S.A. Iron and Steel Industrial Corporation's products, and those of the Union Steel Corporation, and in the first nine months of its existence its turnover had amounted to over £1,200,000.

The present capital of Iscor is £5,500,000, and £1,500,000 was placed on the estimates this year to provide for the additional plant, &c., mentioned above, in case the public does not subscribe. That will bring the total capital up to £7,000,000.

The heavy mill did not start producing until September last year. Taking the figures for the total production of the works up to December 31st, 1935, they are as follows :—Coke, 157,000 tons; pig iron, 144,000 tons; ingots, 102,000 tons; heavy mill, 54,000 tons; light mills, 11,000 tons. The revenue earned was as follows :—

	£
46,081 tons of sections, rails, blooms, billets, &c...	409,908
3509 tons of steel ingots..	14,290
13,587 tons of pig iron	49,917
5286 tons of coke	7,693
By-products	44,495

The costs of production were high per unit, for the reasons already stated. The fact that no provision has been made for depreciation is probably explained by the short period of production; while it is stated that provision has been made, by way of reserves, for the relining of furnaces and for other replacements. It is also stated that costs in the blast-furnace and in the production of steel ingots are now at or near the British level.

Cape Town, July 15th.

Union's Mineral Resources.

ONE of the benefits of the Union's new prosperity is that steps have already been taken, and others have been planned, to place mineral investigation on a sound basis. It is a commonplace that South Africa has abundant mineral wealth apart from its gold and diamonds, its coal and its iron, but of these resources in general, with one or two exceptions, there has been no planned survey, their economic value has not been determined, and there has been no adequate examination of market possibilities. As the result of an organisation now formed, these grounds of criticism will disappear in good time. This organisation rests on the co-operation of the Department of Mines, an inter-departmental Committee for the development of the base mineral industry, and the Witwatersrand University. The Base Mineral Committee has been in existence since the latter part of 1933, and

has accomplished a great deal of valuable work, having prepared reports to the Government on several subjects, including the manganese industry, the possibility of profitably manufacturing ferro-manganese in the Union, copper production and its utilisation in the copper wire industry, and scientific examination of the Union's refractory minerals. It has been, and is, engaged energetically on the task of making accessible and available for public information material in the form of reports and records which had accumulated over a very long period, extending from pre-Union days. Of all this data a proper grouping and mineral classification is now being made and records are being prepared which will present in convenient form all essential details, such as the locality of discoveries, any history of previous working, and all the information available, whether actual or geological, which would assist in assessing commercial possibilities. A *précis* will be made with exhaustive references to existing reports, published articles, &c., relative to each mineral, not only for local use, but for distribution to the Union's representatives abroad, so that they will be in a position at once to satisfy any inquiries that may be made, and to encourage such inquiries. The Geological Survey is closely co-operating with the Mineral Development Branch and other sections of the new organisation and existing memoirs dealing with areas which are geologically attractive in respect to mineral occurrences and those published with reference to specific minerals are being revised and brought up to date, and periodic bulletins will be issued, placing the results of investigation on various minerals at the disposal of the public in convenient form. Another important link in the chain of organisation is the Minerals Research Laboratory specially equipped at Government expense to aid the development of the mineral resources of the Union, and situated at the Witwatersrand University, and already the University staff has been able to undertake an important programme of building expansion which large-scale testing equipment demands. The problem of the treatment of corundum ores and of phosphate concentrate from the Northern Transvaal is now being explored. The treatment of Black Reef gold ore has also been investigated, and the tests demonstrated that the material, though not so amenable to treatment as "banket" of the Main Reef series, may be treated by "all sliming" according to modern practice. One of the staff is attempting to make a soluble fertiliser from the huge phosphate deposits of the Northern Transvaal. If he succeeds, South African agriculture will become independent of other countries for these supplies. Another is studying improved ways of extracting corundum from the difficult ore in which it occurs in South Africa. If successful, the industry may expand considerably. Another task in progress may benefit the Steel Corporation at Pretoria. Fire bricks capable of resisting the high temperatures of the Corporation's furnaces cannot yet be obtained in South Africa, and a worker in the laboratory is experimenting with magnesia which is used overseas for making them.

Water for Greater Durban.

The new water scheme for Greater Durban is to consist of an impounding dam of 5000 million gallons capacity, with flood diversion arrangements capable of dealing with the entire river flow on occasion—a distinctive engineering feature of the scheme. The purification system will include both rapid and slow sand filters and the aqueduct will be 40 miles long. Parliamentary surveys are proceeding in an exceedingly difficult terrain, viz., the Valley of a Thousand Hills, well known to those who have travelled by railway in Natal. These surveys were preceded by an aerial survey, which has been most helpful in locating the best aqueduct route.

Big Rand Railway Scheme.

A costly scheme of railway improvements upon the Witwatersrand railway system, extending from Randfontein to Springs, with Johannesburg roughly at the centre, has been decided upon by the Railway Administration after months of negotiation with the Johannesburg City Council. The City Council's share of the total cost of the scheme will be approximately £450,000. The scheme, which has for its main object the elimination of dangerous level crossings, will cost about £700,000, and will involve the lowering of the railway line at Jeppe, the regrading of the line from Bramfontein subway to Langlaagte Station, and the elimination of all level crossings from Malvern to Langlaagte. The lowering of the Jeppe line will cost £500,000, and means the construction of 1¼ miles of new line. A number of level crossings will be replaced by overhead bridges. The lowered line will be included in the Rand's great railway electrification scheme. The Administration is also making a start with the doubling of the railway line between Langlaagte and Orlando.

Colour Light Signals for Rand Railway Line.

A scheme to remove every semaphore railway signal between Randfontein and Springs and to substitute a system of red, yellow, and green lights is being drafted by the signalling experts of the Railway Administration. The colour light system has been tried in South Africa on a large scale only once before, on the Cape suburban line, where it has proved to be a complete success. Its application to the Rand line, which is 50 miles long, is a far more ambitious project and will be complicated by the vast shunting yards at Braamfontein and Germiston.

Two New Steel Enterprises.

Important developments in the Union's steel industry are expected as the result of the arrival, at the close of June last, of certain business men and engineers who are to take charge of two new steel construction works at Johannesburg. Of these arrivals, a party of nine engineers is to open a steel construction works at Germiston, near Johannesburg. These men are under two years' contract and will be employed by Wade, Dorman and Co., an offshoot of Dorman, Long and Co., of Middlesbrough, England. Their work will chiefly be bridge construction, it being considered that now the Union has its own steel works the company can get its steel requirements locally and make what articles the company requires in this country. This will save freight and Customs charges and also the tariff charges on imported steel articles which the Government is bound to put up to protect its own industry. One other arrival is opening up steel works on the Rand. He is Mr. W. H. Everard, who is going to a foundry at Benoni as manager of a new steel casting department which is to be started there. Six key men from his firm's steel works in England will follow Mr. Everard as soon as things are settled here. The rest of the labour it is hoped to get locally.

Fast Aeroplane Service.

The new Junker aeroplane named "Sir Benjamin d'Urban" has arrived at Johannesburg and brings the number of three-engined seventeen-passenger Junker machines acquired by the South African Airways up to four. On June 24th the fastest commercial flight, so far, between Durban and the Rand was made by one of these Junker planes, the "Lord Charles Somerset," which, carrying eight passengers, covered the 320 miles between Durban and the Rand airport in 1 hour 44 minutes, or 185 m.p.h. The commercial aircraft record for the down journey from the Rand airport to Durban is 1 hour 40 minutes, so that the mail plane "Sir Charles Somerset," with its 6000ft. climb from the coast, came within four minutes of the record for the less arduous journey from the Rand to Durban.

Consumption of Electricity.

Statistics taken over a wide range in September, 1934, show that there were 29,453 consumers of electricity (private dwellings) in Cape Town, against 17,313 in Durban and 31,507 in Johannesburg. The number of units consumed per consumer was 183·6 for Cape Town, 276·9 for Durban, and 96·6 for Johannesburg. The average charge per unit was 0·967d. for Cape Town, 0·895d. for Durban, and 1·545d. for Johannesburg. The greatest percentage increase in the number of consumers, number of units consumed, and approximate revenue from this source occurred at Benoni. The greatest percentage increase in the number of units consumed per customer occurred in Cape Town.

Geodetic Survey of the Union.

A party of seven land surveyors, having Mr. H. S. K. Simpson as leader, have assembled at Mtubatuba, in Zululand, having been appointed by the Union Government to measure a geodetic survey base approximately eight miles in length along a site selected for that purpose. A party of surveyors under the leadership of Mr. H. E. Maasdorp, who was lent by the Rhodesia Government, set out from Cape Town for Namaqualand last March on a similar mission. The actual measuring of the Northern Zululand base will be followed by an astronomical programme. The geodetic survey of the Union began in the year 1880, when Sir Thomas Maclear set about measuring an arc of the meridian in the southern hemisphere. This work was later extended by Sir David Gill and Sir William Morris. The present work is being undertaken with apparatus designed by Capt. G. I. McCaw, of the Royal Engineers, which has been loaned to the Union Government by the British War Office.

Manganese Shipments.

The largest cargo of manganese ore to leave Durban port for over three years is being shipped in the German freighter "Baden" next month. Over 9000 tons will be loaded and it is understood that the Continent is the ship's destination. During the first five months of the year 37,407 tons of manganese have been shipped, and at the close of June another 3000 tons were exported. The indications are that last year's total of 73,257 tons will be exceeded, especially as the railway to the new manganese deposit just beyond the Postmaasburg deposit will soon be open for traffic.

Death of Cape Town City Engineer.

Mr. T. P. Francis, City Engineer of Cape Town, died on Sunday night, July 7th, very suddenly from heart failure, at the age of thirty-nine years. He was appointed City Engineer for Cape Town in 1933, and had been in the service of the municipality less than eighteen months, but had impressed all with his administrative zeal and high professional ability. He was a member of the Institution of Civil Engineers, Fellow of the Surveyors' Institute, member of the Institution of Municipal and County Engineers, of which he was also thesis prize man and gold medallist, and a Fellow and Examiner of the Institute of Sanitary Engineers.

Coaster Development During the Past Fifty Years.*

By F. W. DUGDALE.

It is only in comparatively recent years that the need for further development of the coastal trade, and the fact that a highly developed coastal shipping trade would lead to a general cheapening of goods, have been fully realised. This development not only necessitated improved design in the vessels so employed, but better and more modern equipment of the many small ports round the coast.

The design of coastal vessels presents special problems: limitations of dimensions, draught, and speed, come in for special consideration. As to type, probably the raised quarter-deck vessel, with machinery aft, has established itself as the most suitable and is incidentally cheaper to construct than a vessel with machinery amidships with one hold forward and one aft. In such a vessel the two holds are too small to be of real value, particularly in small vessels, and, furthermore, a tunnel in the after hold reduces capacity, apart from its other disadvantages. Many vessels of this class load and discharge in tidal harbours in which the bottom may be neither smooth nor level, and as the tide may leave the vessel high and dry, special consideration must be given to bottom construction.

In the early part of the period under review—1884 to 1935—steam was definitely established as a reliable motive power. The first steam collier, the "John Bowes," had been built thirty-two years earlier, at Palmers, Jarrow, in 1852. She carried a deadweight of 650 tons, and was not only a success, but her advent marked a very definite advancement in collier design. Sailing ships, however, were still a frequent sight in our ports and along the coast, though undoubtedly they were giving way to steam and gradually disappearing. Just as steam was displacing sail, so were the wooden ships giving place to iron, and later to steel-built vessels. Sail, however, was not to be entirely eliminated, for with the introduction of auxiliary machinery, this type of vessel took a new lease of life, and many such vessels are still operating in the coastal trade to-day, fitted generally with some type of internal combustion engine as auxiliary power.

The change-over from iron to steel was established in about 1877 following the Siemens Martin or open-hearth process of manufacture. Prior to this there had certainly been vessels constructed of steel, but plans submitted to Lloyd's for their approval of the construction of such vessels were treated with due caution, and if accepted were classed with the notation against their characters, "Experimental." Not until 1888 were the first rules for steel ships framed, and by this time the change-over was almost complete, and steel had almost entirely superseded iron to the extent of about 90 per cent. of vessels built other than of wood. For many years after this date, however, iron was utilised by some firms in certain parts of the vessel, as, for example, tank tops, exposed decks, engine and boiler seatings, auxiliary seats, &c., the hulls being constructed of steel.

The cellular double bottom had already made its appearance about twenty-seven years previously in the "Great Eastern," built in 1858. In reality it was a double shell and longitudinal framing. Built-up floors and the McIntyre tank—built about 1852 at Palmers, where, I believe, the inventor was manager—were gradually superseded by a type of construction very similar in principle and design to the cellular double bottom tank formation of to-day, and even in that form we cannot claim it as having been evolved during the last fifty years, for I believe it first came into being about 1874.

I hope I shall be forgiven for overstepping the period I have been asked to deal with, but certain events prior to '84 I consider of interest and importance; furthermore, they formed the basis upon which subsequent development depended. It is interesting to record that water ballast was first tried as early as 1852, though it was then carried in water-tight bags, and two years later flat tanks were placed on the ordinary floors, leading up to the later development in which the bottom of the ship formed the bottom of the ballast tank.

The first bracket system of double-bottom design had been introduced about 1876, jointly by a prominent Tyne and Wear builder. It consisted of solid floors about eight

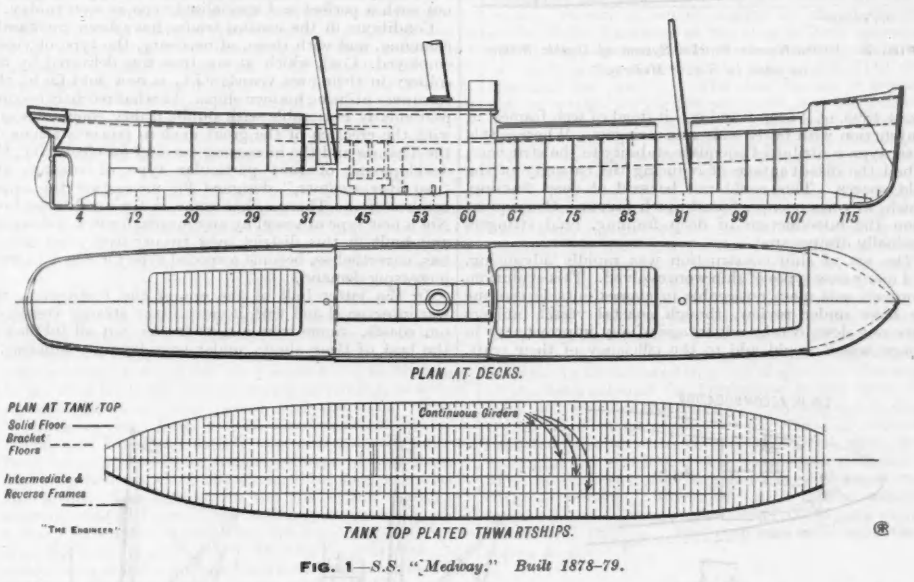

4 12 20 29 37 45 53 60 67 75 83 91 99 107 115
PLAN AT DECKS.
PLAN AT TANK TOP
Solid Floor
Bracket Floors
Intermediate & Reverse Frames
Continuous Girders
"The Engineer"
TANK TOP PLATED THWARTSHIPS.

FIG. 1—*S.S. "Medway." Built 1878–79.*

* North-East Coast Institution of Engineers and Shipbuilders, July 17th.

frames apart, bracket floors half way between, and then midway again frame and reverse frame with continuous longitudinal girders—Figs. 1 and 2. This was considered a definite advancement and the best form of tank at that time. It is interesting to note that in the early days of double bottoms they were partially measured into the tonnage, and not until later was the measurement to tank top obtained.

In 1890 came the change from Frame and Reverse to the Bulb Angle type of framing, a very welcome introduction which has become extremely popular, due to its simplicity, and perhaps even more so due to its greater resistance to corrosion than that afforded by the frame and reverse. It will therefore be seen that this was not the idea of a ship-repairer. This was soon followed by the introduction,

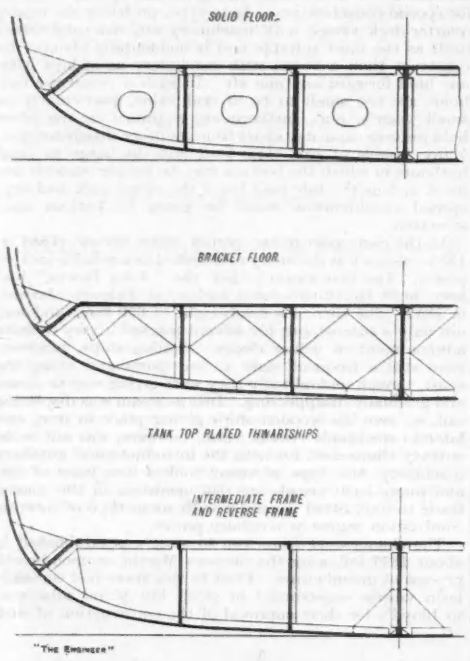


FIG. 2—*Austen-Hunter Bracket System of Double Bottom as fitted in S.S. "Medway."*

about 1895, of "deep framing," instead of web frames, in conjunction with fairly wide side stringers. Whereas this latter type contributed adequate stability to the structure, it had the disadvantage of reducing the capacity of the hold spaces. This could not be said of deep framing, which, in consequence, found much favour. Consequent upon the introduction of deep framing, hold stringers gradually disappeared.

The art of ship construction was rapidly advancing, and many new types of ship were evolved. This evolution, however, was most noticeable in classes outside the one we have under review, though coastal vessel builders were not slow to take advantage of any improvement in design which would add to the efficiency of their craft. Perhaps the next step of importance to record was the introduction of "longitudinal framing," the invention of Sir Joseph Isherwood, Bart., then (about 1896) a surveyor to Lloyd's Register in Middlesbrough. The first ship built on this system was completed on the Tees, in 1908. This form of construction had many advantages over the transverse system of framing for certain types of vessel. The longitudinal strength was considerably increased, and, in addition, the reinforcement by the longitudinal girders of the thinner deck plating and expansion trunks better resisted buckling. It also meant a considerable saving in steel material and though principally adopted in the construction of larger vessels, it has been utilised to no small extent on the coast, principally for tankers, for which class of vessel it was peculiarly adapted, and to the success of which type of vessel it has greatly contributed.

In view of the amount of oil carried in bulk coastwise to-day reference to tankers is quite appropriate. These vessels as a class date from 1885, and therefore are practically contemporaneous with the Institution. The early tankers could hardly be classed as coasters, but the development of this type of vessel in the coastal trades soon made its appearance.

Though perhaps not the next type of importance to make its appearance, reference to the coastal motor ship is not out of place, in view of its relationship to the tanker. Its evolution has, indeed, been rapid, for it is less than twenty-five years ago since the internal combustion engine was first adopted as a form of merchant ship propulsive power. Thirty years ago a number of small craft had been fitted with internal combustion engines, using various fuels, ranging from petrol to heavy hydrocarbon oils, and it was about this period that consideration was given to their possibilities in ocean-going vessels. Early difficulties in the matter of cooling arrangements, reversing, &c., were soon overcome, and the motor ship made its appearance as an ocean-going craft, the first receiving Lloyd's Class in 1910. To-day the motor coaster is a common sight, and of a type which is attaining increasing popularity in certain trades. Fig. 3 illustrates a modern motor coaster designed for a deadweight-carrying capacity of 450 tons, on a 13ft. 3in. draught.

Owners who have a trade for this class of vessel and who have once made the experiment in place of the steam coaster, speak in the highest terms of their increased efficiency, economy, and usefulness; but, of course, they are not suitable for all classes of coastal trade, and I would be the last to make a sweeping statement to the detriment of the steam coaster. With the introduction of the motor ship, the importance of electricity became very marked, not only for lighting and wireless purposes, but for operating the vessel's auxiliaries.

A type of coaster very frequently seen in comparatively modern times and one which was very popular, was the "Three Island" or "Fredrikstad" type, with winches on poop, bridge, and forecastle. It was used for both the coal and timber trade, but was most suitable for the latter. As competition increased, not only at home, but from the foreign owner, and the time for specialisation arrived, it was realised that this type was not ideal for each trade; requirements for the one did not suit the other. We then saw the establishment of the "raised-quarter-deck" type, with machinery aft and large clear holds with self-trimming hatches for the collier; but I am not suggesting that vessels of this type had not been seen earlier, for they were in existence before the Fredrikstad type, though of not such a perfect and specialised type as seen to-day.

Conditions in the coastal trades have been constantly changing, and with them, of necessity, the type of vessel employed. Coal, which at one time was delivered by the colliery in their own vessels c.i.f., is now sold f.o.b., the consumer utilising his own ships. This has recently become particularly noticeable with public utility companies and with the erection of the great modern power stations on the Thames and the increasing demand for electricity, the development of that particular type of coaster, the "up-river steamer," designed for navigating the upper reaches of the Thames, has come in for much attention. Not a new type of vessel by any means, for it was designed and built in this district over twenty-five years ago, it has, nevertheless, become a special type for which there is increasing demand.

In the latter half of the era of the Institution, the war intervened and with it came many strange vessels on our coasts. Some were almost freaks, but all fulfilled to the best of their ability under very trying conditions, a useful purpose to a greater or less degree. In those days the naval architect could hardly be said to have had a free hand; material was a difficult proposition—almost as much so as the conditions under which we lived. "Kil" boats, concrete ships, fabricated ships, standard ships, and many others were built to meet the national demand. Perhaps of the wartime craft on the coast, those of most local interest were certain types of standard ship which were designed for the Admiralty by North-East Coast shipbuilders, and built in various yards throughout the country.

The post-war trade slump brought keen competition among builders, lack of freights and consequently of orders, and the naval architect has made every effort to meet the situation by producing vessels of greater economy and efficiency. Special consideration has had to be given to the requirements of each particular vessel and the trade in which it is to be employed. No expense has been spared; data have been obtained from the performance of vessels at sea and by tank experiments, resulting in a more perfect form of hull and appendages. Main engines and auxiliaries have also come under review and everything possible has been done to cut down running costs, with the result that a combination of the efforts of the shipbuilder and engineer has achieved the object in view. It would be idle to say that this cannot be improved upon, but I venture to state that in no other similar period during the past fifty years has so much advancement been made in ship design as in recent post-war years. This statement applies to all vessels, but builders of coastal craft have not been slow to realise the advantages of a perfect form, of streamlining, not only of the hull, but the stern frame and rudder; and also of improved and suitable propeller design for each type of vessel.

Hatches became a special problem on the coast, partly, but not entirely due to the increased size of hatches demanded by the collier. To meet this, various types of steel hatch covers have been introduced, and though not suitable for all vessels in this particular trade, mark a definite advancement on the old type of wood cover. The requirements for each particular vessel have had to be considered on their merits, but it was generally felt that there was room for improvement, and with the improved type of hatch cover came improved design in coamings. A clear hatchway, free from obstruction, was essential, particularly with colliers and vessels discharging

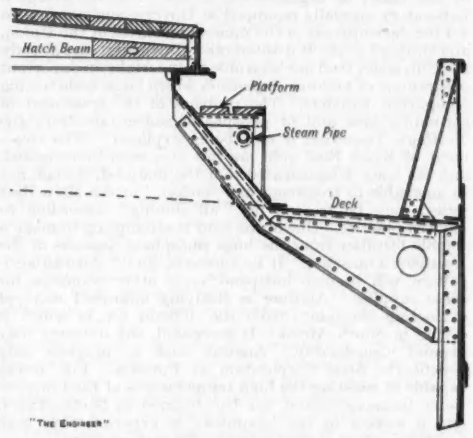


FIG. 4—*Modern Form of Hatch Construction Embodying Reith Type Bulb Angle Coaming.*

with grabs. Hatch beam shoes or slides were a constant source of revenue for the ship repairer, and though there may still be some who consider that these have a right to live, a design has been introduced eliminating these obstructions in the hatchways, and the beams are lodged on horizontal bulb angles between similar vertical sections—Fig. 4. Simple as this arrangement is, it is quite modern, and though many claims have been made for its invention, it is remarkable that shipbuilders had not introduced it many years ago.

Hatch coamings are also sloped, so improving the trimming facilities and adding to the cubic capacity of the holds. It must not be assumed that this is a modern invention, for a similar form of coaming was brought out by Price about 1874; it was not, however, greatly used till more recent years, and to-day is a usual design in coal-carrying vessels.

Comment on coasters during the past fifty years, however brief, would not be complete without reference to the introduction of the electrically welded ship. The "Moira," built this year by Swan, Hunter and Wigham Richardson, Ltd., is an instance of such a vessel. While the Mersey may claim to be the pioneer in the introduction of the welded ship, the North-East Coast is entitled to much consideration and credit for its enterprise and experimental work which undoubtedly has had much to do with the now favourable attitude of classification societies to this branch of the shipbuilder's art.

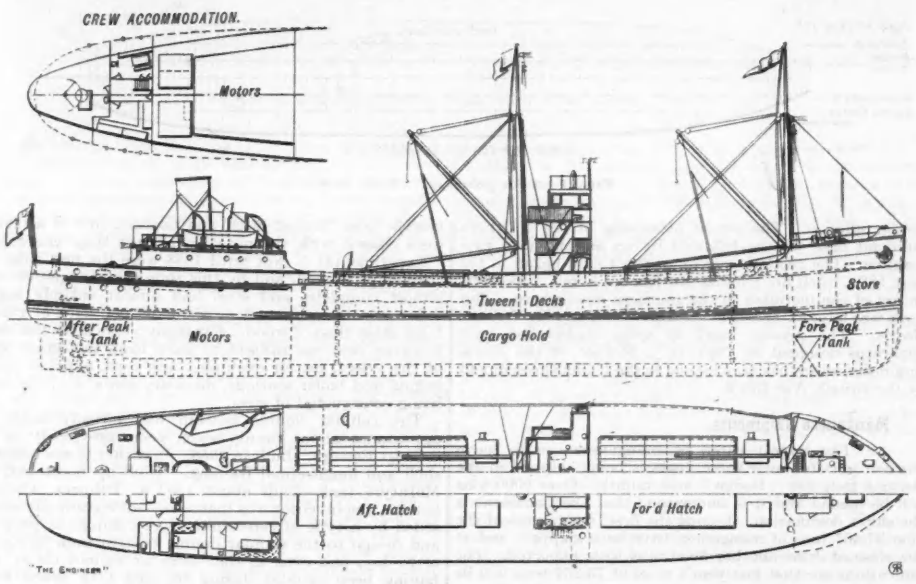


FIG. 3—*Type of Modern Motor Coaster about 950 Tons d.w.t. on 13ft. 3in. Draught.*

BRITISH STANDARDS INSTITUTION.

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria-street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.

GRINDING WHEELS.

No. 620—1935. A new specification, B.S.S. No. 620—1935, has recently been issued for the dimensions of grinding wheels and method of attachment. The Committee responsible for the specification has considered only those shapes which are in general use. It has sought to provide a range of wheels which will adequately cover the general demands of the engineering industry, every endeavour having been made to eliminate special and unnecessary shapes and sizes. It recognised that there will always be a demand for grinding wheels necessary for some particular purpose or special work which do not conform to the standard sizes, and has made no attempt to cover such cases, as to do so would tend to defeat the purpose of standardisation. The necessity for adequately fastening the wheels is provided for by including tables of dimensions for standard washer plates, together with details as to the quality of material from which they should be made, and of methods of fastening. The practice of making the diameter of the safety plate not less than half the diameter of the wheel has been adhered to. The Committee is of the opinion that the variation in the sizes of wheels at present demanded by the engineering industry could readily be reduced and it strongly recommends that every endeavour should be made to work to the sizes that have been standardised.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

New Iron and Steel Duties.

In accordance with the agreement recently concluded between the Continental Steel Cartel and the British Iron and Steel Federation, an Additional Import Duties Order (No. 27), 1935, has been issued, whereby the customs duties on the following iron and steel products will be reduced from August 8th to 20 per cent., *ad valorem*, for a period of five months :—Blooms, billets and slabs, not exceeding £7 10s. per ton in value; bars and rods (other than rods in coils), not exceeding £9 per ton in value; angles, shapes and sections, not exceeding £15 a ton in value; girders, joists, beams, and pillars; hoop and strip, not exceeding £16 a ton in value; rails. In addition to the above-mentioned goods, the Committee recommend that the following be also made subject to the reduced rate of 20 per cent.:—Plates and sheets of all kinds not exceeding £16 a ton in value; rods and coils not exceeding £9 a ton in value; barbed wire, single-strand wire and upholstery and mattress springs; galvanised hexagonal wire netting, and nails. These goods are to form the subject of a further Treasury Order. As from August 3rd the customs duties on the cheaper grades of iron and steel tubes and pipes (other than cast tubes and pipes) will be increased from 20 per cent.: (1) Where their value is less than £13 per ton, to £5 per ton, and (2) where their value is £13 per ton or over, but does not exceed £15 per ton, to such an amount as equals the difference between the value per ton and £18. The duty on tubes and pipes of a value of more than £15 per ton and on all cast tubes and pipes remains unchanged at 20 per cent. The Import Duties Advisory Committee points out that as a result of the termination of the International Tube Cartel there is a threat of intense competition from foreign producers at cut prices, and in the absence of adequate protection the home market would be handicapped both in meeting open competition or in negotiating a new international agreement. The duty on weldless steel tubes was limited to 20 per cent. maximum by Article 2 of the Trade Agreement with Sweden; but the British and Swedish tube industries have reached an agreement which permits the scale of duties now imposed.

Pig Iron.

Although there was a general expectation that prices of foundry iron would be advanced, no decision has so far been arrived at in spite of several conferences of the makers' representatives at which it is understood there was some difference of opinion as to the desirability of advancing prices at the moment. Production in the Middlesbrough area has been steadily increased, and all outputs continue to meet a ready clearance with good quantities despatched to Scotland. Following the recent advance in East Coast hematite, the demand has slackened off to some extent, though this was not entirely unexpected, owing to the large quantities ordered before the recent rise in prices came into force. Italy is in the market for large supplies, but the difficulties of arranging for payment appear to be holding up the business temporarily. Apparently the full schedule of East Coast hematite prices under the revised arrangement has not yet been published. In the Midlands holidays are more or less in progress, but the augmentation of stocks at blast-furnaces which these involve occasions no anxiety in the present position of pig iron. While there are strong reserves at some Derbyshire furnaces, the total output has scarcely kept pace with demand during recent months. After long deliberation the Central Pig Iron Producers Association has decided not to advance prices this month. It is stated that the consideration which weighed with it was the anxiety of the Government that there should be as little disturbance of market values as possible. If the rebate on rail-borne blast-furnace materials should be discontinued, as is considered likely, the increase in production costs would necessitate revision of selling prices. As to hematites, which were advanced at the opening of the quarter, the position is ambiguous. Some grades are being priced on the principle of analysis. The local demand for West Coast hematite continues on a large scale and consumes rather more than half of the total outturn of the seven furnaces in blast between Workington and Barrow. There has been a good volume of forward buying, and the entire production to the end of the third quarter has been practically disposed of. In the West of Scotland there was a steady demand for pig iron, and the present limited output was fairly readily cleared in spite of the keen competition of Indian pig iron and of that from the Midlands.

The North-East Coast and Yorkshire.

The feature of the past month in the Middlesbrough area was the revival in the export demand for iron and steel, shipments from the Tees during the month totalling 49,259 tons, compared with 27,455 tons in June. The oversea exports of finished iron and steel amounted to 26,647 tons, against 15,161 tons in June. The pig iron position remains practically unchanged with all outputs moving steadily into consumption. There was no fresh development in the market for foreign ore, as most consumers have booked up to the end of the year at low prices. However, orders for prompt parcels can only be supplied at the rate recently quoted by shippers, and higher rates are indicated for forward business. The outturn of steel in this area is exceptionally heavy, as makers have large orders on hand for steel billets and sheet bars, and have no anxiety regarding Continental competition. The demand for finished steel displayed some irregularity, but there was still a considerable volume of orders, and these are likely to be augmented in the near future owing to the large projects under contemplation. Production is due to start shortly at the new coal-oil works which are being constructed at Seaham Harbour. Seventeen large petrol storage tanks, each with a capacity of 100,000 gallons, and a gasholder with a capacity of 80,000 cubic feet, have been built by electric welding, and there is a water tower 100ft. high of lattice girder steelwork. A large carbonising battery, composed of fire-brick, will be able to deal with 500 tons of coal per day. In the Sheffield area holiday influences have prevailed to some extent, but the slowing down has been much less pronounced than usual at this period of the year. There was some talk of the probability of an all-round rise in prices of foundry and forge iron, but the consensus of opinion at the moment is that there will be no change for some time yet. The recent fillip in the demand for forge iron was about maintained, and the consumption of other descriptions leaves no cause for complaint, as producers have sufficiently good orders to keep them busy during the next few months. In the market for finished iron marked bars attracted a steady demand and there was quite a brisk business in common bars, prices for both descriptions being fully maintained. The steel position remains intrinsically sound owing to the keen demand for basic billets and continued active purchasing of acid billets. Steel strip was a particularly good feature, with satisfactory orders for wire rods, whilst orders for stainless and special steels came along in steady volume. In order to enable producers to deal more effectively with the larger orders which are coming to hand, several more electric furnaces are to be installed. The heavy engineering branch is well booked forward and producers of railway material reported themselves as well pleased with the amount of work booked during the past month.

Scotland and the North.

The shipbuilding position on the Clyde has undergone some improvement, as fresh contracts for seven new vessels were placed with Clyde yards during the past week, and inquiries are circulating for tanker and general cargo tonnage with the likelikood that further orders will be placed during the ensuing two months. On the Forth conditions are a little more satisfactory, whilst in Aberdeen shipbuilders have a fair amount of work in hand. In the Glasgow area a quiet business was reported in pig iron, with steady deliveries to the foundries. The steel works resumed operations with a fair amount of work in hand, and are continuing to take substantial tonnages of hematite and basic. All departments of the manufacturing trades in iron, steel, and allied products appear to be well employed, though influenced to some extent by the holidays over the border. There was a fairly steady volume of specifications for plates and sections, but the output is much below capacity. Re-rolled steel sections met a steady call, and there was no notable decrease in the demand for bar iron. The home demand for black sheets provided makers with steady employment, there being an exceptionally keen inquiry for heavy gauges, though the lighter descriptions and galvanised sheets were again in poor request. On the North-West Coast, activity was well maintained, and during the past week much encouragement was derived from a definite revival in the export demand. Good inquiries were received from South Wales and the Midlands, and large tonnages are being delivered on current contracts. Malleable iron had a ready sale for despatch to the Midlands. In the steel trade the outlook is very promising, as several repeat orders have been placed with the mills. In the Workington area large orders were received for rails, billets, and bars, and satisfactory orders have come to hand for steel sleepers for Indian railways. In the Barrow district producers are busily engaged on steel strip, rails, and hoops. The holidays in the Manchester area have seriously retarded operations, and outputs generally show a sharp reduction. Apart from this temporary lull, however, the position gives every cause for congratulation, as most concerns have sufficient work to keep them steadily employed for some weeks. In the steel branch there was a moderate inquiry for joists and structural material generally, and there was no falling off in the call for special steels.

Current Business.

Orders have been received by Henry Robb, Ltd., of Leith, for a passenger steamer for India, a medium grab type dredger for Colonial owners, and a Diesel-engine tug for the General Lighterage Company for use on the Thames. The company also has contracts in hand for pontoons and other small craft. Lithgows, Ltd., have received a contract for two vessels, each of 7500 tons d.w., for the Scindia Steamships (London), Ltd. The Australasian United Steam Navigation Company, Ltd., has placed an order with Scott and Sons for a motor ship, 250ft. in length, and the same company has received a contract from J. and A. Gardner and Co., Ltd., of Glasgow, for a motor ship of 500 tons; a cargo vessel of 1000 tons for South African owners; and a tug for Haifa from the Crown Agents for the Colonies. A contract, valued at £35,000, has been placed with Robert Stephenson and Co., Ltd., of Darlington, for seven broad-gauge superheated tank locomotives for the South Indian Railway. Hurst, Nelson and Co., Ltd., Motherwell, have received an order for four 12-ton wagons from the London County Council. An order for 3500 tons of steel rails and 210 tons of fish-plates has been placed with Dorman, Long and Co., Ltd., Middlesbrough, by the Chinese Government for the Peiping-Hangkow Railway. The Department of Overseas Trade reports that the following contracts are open for tender :—Egypt: Ministry of Public Works, 17,500 kilos. of mild steel plates, from $\frac{1}{4}$in. to $\frac{3}{8}$in. thick; 11,000 kilos. of galvanised corrugated sheets; 22,000 kilos. of mild steel angles; 60 kilos. of $\frac{3}{8}$in. hexagonal nuts and 70 kilos. of galvanised washers (Cairo, August 24th). Conseil Sanitaire Maritime et Quarantenaire d'Egypte: Smoke tube type boiler to supply five disinfectant chambers (Alexandria, August 29th). Viacao Ferrea do Rio Grande do Sul: Supply of engineers' files (Brazil, August 30th). South African Railways and Harbours Administration: Structural steelwork, &c., for a cargo shed at Port Elizabeth Harbour (Johannesburg, September 9th); shovels, picks, ballast forks and handles (Johannesburg, September 23rd); supply and delivery, f.o.b. ship, of one 7-ton steam travelling crane with electric magnet (South Africa, September 16th). India Stores Department: Eight sets of worm gears driven by electric motors of the totally enclosed squirrel-cage type, for punkah pulling (Simla, August 27th). Argentine State Railways: 230-volt D.C. generators, driven by Diesel oil engines, together with one rotary oil pump, four 10 h.p. D.C. electric motors, switchboards, &c. (Buenos Aires, September 9th); supply of aluminium, antimony, tin, pig iron, reducing metal, lead and zinc (Buenos Aires, August 21st); special lathe for turning wagon axles; grinding machine for trueing the surface of wagon axle journals, and grinding machine for trueing locomotive crank pins (Buenos Aires, September 2nd); 8880 kilos. of special foundry steel in flats and rounds containing from 8 to 10 per cent. tungsten and from 2 to 3 per cent. chromium (Buenos Aires, August 20th). Argentine National Sanitation Works Dept.: Seventeen electric pumping sets for deep well service (Buenos Aires, August 27th). New Zealand Public Works Dept.: 30 seamless steel acetylene gas cylinders, outlet valves and protecting caps (New Zealand, October 1st).

Copper and Tin.

Quiet but slightly firmer conditions have prevailed on the standard copper market during the past week. At the outset there was some easiness, due to a certain amount of liquidation, but latterly, with much more cheerful advices from the United States, the market here gradually firmed up. The undertone remains firm, and with an increasing consumption, both in Europe and America, the position looks quite sound. The domestic quotation for electrolytic in New York remains at 8·00c. per lb., whilst the c.i.f. Europe quotation now stands at 7·90c. per lb. It is reported that Japan has purchased a considerable quantity of copper in the United States, and Italy also has been a good buyer during the past few weeks. Stocks of refined copper in official warehouses of the Metal Exchange at the close of July amounted to 73,294 tons, against 29,129 tons a year ago, whilst stocks of rough copper were 11,334 tons, against 7142 tons at this time last year. . . . The chief feature of interest on the tin market during the past week was the publication of the monthly statistics, which disclosed a decrease of 918 tons in the visible supply to 12,623 tons, but the carry-over in the Straits showed an increase of 1398 tons at 2240 tons, a net increase of 480 tons on the month. The market has been helped by the good rate of consumption in the United States, where deliveries during July totalled 5290 tons, against 4615 tons in the previous month. Consumption here and on the Continent has been well maintained. The backwardation, however, remains wide at about £14, but some relief is expected with the arrival of 1200 tons of Straits tin which has been reshipped from New York. The return of this portion of the buffer stock from America caused a good deal of indignation in the tin trade on that side, especially among consumers who visualise an accentuated shortage of spot tin. The meeting of the International Tin Committee at the close of this week will consider the question of raising the production quota, which is at present 50 per cent. It is generally expected that an increase will be agreed upon, and in most quarters it is hoped that the increase will date from July 1st in order that supplies may be augmented as early as possible. Stocks of tin in official warehouses at the close of July amounted to only 1246 tons, excluding Banca and Billiton. The premium on Straits tin now stands at about £5.

Average Non-ferrous Metal Prices.

The average prices of all the principal metals dealt in on the London Metal Exchange show an increase for July. In the case of cash copper the increase was 4s. 8d. over the June figure, for three months 5s. 6d., and for settlement 4s. 9d., whilst for electrolytic and wire bars the average was 4s. 6d. higher. Best selected copper advanced by 3s. 10d. In the tin market the rise was even more pronounced and the average for cash tin was £4 18s. 4d. over that for June. For three months the price is £3 17s. 11d. higher and for settlement £4 19s. 11d. up. Lead, for current month shipment, advanced by 13s. 6d., for shipment the third following month by 14s. 1d., the mean price by 13s. 10d., and the settlement price by 13s. 9d. over the average for June. The average price for spelter showed an increase of 6s. 7d. on shipment for the current month, of 5s. 9d. on shipment for the third following month, the mean being 6s. 3d. and the settlement price 6s. 7d. higher than the average for the previous month. The following are the London Metal Exchange official average quotations for July :—

Standard Copper	Cash	£31	1	4 22/48
	3 Months	£31	9	7 1/48
	Settlement	£31	1	7 13/48
Electrolytic Copper		£34	11	10 24/48
Electrolytic Wire Bars		£34	18	5 11/48
Best Selected Copper		£33	16	11½
Standard Tin	Cash	£232	12	7 3/24
	3 Months	£223	8	8 8/24
	Settlement	£232	14	4 4/24
Lead	For shipment the current month	£14	9	0 6/24
	For shipment the third following month	£14	10	2 14/24
	Mean	£14	9	7 10/24
	Settlement	£14	9	4 4/24
Spelter	For shipment the current month	£14	1	3 1/24
	For shipment the third following month	£14	3	8
	Mean	£14	2	6
	Settlement	£14	1	3 1/24

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. Coast—		
Hematite Mixed Nos.	3 14 0 d/d Glasgow	
	3 18 6 „ Sheffield	
	4 4 6 „ Birmingham	

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

	Home.	Export.
London and the South—	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	8 5 0
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 7 6	8 5 0
Boiler Plates, ¼in.	9 7 6 .. 7 15 0 to 8 5 0	

STEEL (*continued*).

	Home.	Export.
Glasgow and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	8 5 0
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 6 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G. to 13-G., f.o.r.	9 10 0	8 15 0
14-G. to 20-G., d/d	10 15 0	9 0 0
21-G. to 24-G., d/d	11 0 0	9 5 0
25-G. to 27-G., d/d	11 12 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·70 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale 5/– p.u.	
„ „ 75 p.c.	£17 17 6 scale 6/– p.u.	
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, August 7th.

Copper—		
Cash	£32 6 3 to £32 7 6	
Three months	£32 13 9 to £32 15 0	
Electrolytic	£35 10 0 to £36 0 0	
Best Selected Ingots, d/d Birmingham	£35 15 0	
Sheets, Hot Rolled	£62 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9¼d.	9¼d.
„ Brazed	11¼d.	11¼d.
Tin—		
Cash	£233 15 0 to £234 0 0	
Three months	£216 15 0 to £217 0 0	
Lead: Cash and forward	£15 10 0	
Spelter:	£14 3 9 to £14 7 6	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—Navigation Unscreened	13/6 to 13/9
„ Glasgow—Ell	14/6
„ „ Splint	17/– to 17/6
Ayrshire—	
(f.o.b. Ports)—Steam	13/– to 13/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	13/– to 13/6
Lothians—	
(f.o.b. Leith)—Hartley Prime	12/6 to 13/6
Secondary Steam	12/–

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	13/– to 16/–
Northumberland, Newcastle—	
Blyth Best	13/6 to 14/–
„ Second	13/3 to 13/6
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Special Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	23/– to 25/–
South Yorkshire Best	20/– to 22/–
South Yorkshire Seconds	17/– to 18/6
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	25/– to 40/–
Furnace Coke	19/– to 21/–
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondent in Paris.)

City Improvements.

IN carrying out municipal undertakings as part of a general scheme to provide employment, more progress is being made than would otherwise have been possible with plans for improving Paris that comprise increased public transport facilities, water supply and sanitation, widening congested streets by the demolition of old buildings, adapting thoroughfares and bridges to modern road traffic conditions, and the general embellishment of a city that has extended and changed in character since the fortifications were levelled and the architect and town planner were given a relatively free hand. That freedom of planning is now to be kept within bounds by regulations that are being drawn up to comply with the requirements of a general plan. In building there was too much anticipation of needs that failed to be met in a manner acceptable to the public. Several years ago the Paris municipality attempted to grapple with the serious problem of providing habitations at low rents by constructing blocks of flats with all modern conveniences along the 22 miles' site of the fortifications. They have given a new aspect to that part of the city, but the blocks were erected at a time when labour and material costs were at their highest, and the necessity for raising rents has left the flats for the most part unoccupied. The slump in building is largely responsible for the slackness of demand for steel and other materials. There are, however, symptoms of renewed activity in consequence of the necessity to complete many of the more important works in time for the Paris Exhibition of "Arts and Technique" in 1937, notably the Metropolitan Railway extensions which are being carried out on an elaborate scale.

Electrical Engineering.

In its annual report the Chambre Syndicale de la Construction Electrique declares that the heavier branches of electrical engineering have suffered more than any other industry. In 1933 the orders for heavy electrical machinery had already fallen by 75 per cent. compared with 1930, and last year a further reduction was only averted by work given out for railway electrification; but that relief was temporary, for during the first four months of the present year the value of orders declined by 36 per cent. compared with the similar period of 1934. Taking into account all descriptions of electrical machinery, the reduction in 1934 was more than 50 per cent. of the total for 1931. The export trade was maintained, but only at a great sacrifice in price, which was the more serious because prices were not profitable on the home market. Foreign competition, says the report, was reduced by quotas and by international agreements amongst manufacturers. The slump in heavy electrical machinery is explained by the fact that enterprise in hydro-electric equipment and the installation of power stations in Paris and other centres, as well as in colliery districts, had reached a peak from which there was a sharp drop when the industrial depression left a notable surplus of electricity production, and capital abstained from embarking upon many of the hydro-electric schemes that are still in abeyance. An economic recovery is likely to see a renewal of enterprise which will bring activity to electrical engineering. Meanwhile, some big hydro-electric undertakings are being completed, or have recently been put into service, notably the Sautet dam, 413ft. high, in a narrow gorge on the river Drac, which impounds 130 million cubic metres of water, and the Marèges dam on the Dordogne, which has been constructed for the Paris-Orleans Railway Company.

The New Cruisers.

The third of the six 7600-ton cruisers, "Jean-de-Vienne," was floated out last week from the construction dock at the Lorient arsenal. The other two cruisers are "La Glissonnière," launched at Brest towards the end of 1933, and the recently launched "Marseillaise." The remaining three ships, "Montcalm," "Gloire," and "Georges-Leygues," are being built at the Seyne yard of the Forges et Chantiers de la Méditerranée, the Chantiers de la Gironde, and the Chantiers de Penhoët. They are all of one type with an armoured belt and protected deck. Their Rateau turbines develop up to 88,000 h.p., and are supplied with steam from Guyot-Du-Temple boilers. The designed speed is 32·5 knots. The armament consists of nine 155 mm. guns, eight 90 mm. and eight 37 mm. anti-aircraft guns, and each will carry two seaplanes. The cruiser launched last week, "Jean-de-Vienne," is named after an admiral who, between 1377 and 1385, harried the South Coast of England, where he attacked Rye, Rottingdean, Portsmouth, Plymouth, and the Isle of Wight, fought battles and burnt Hastings, defeated an English fleet off Cherbourg, captured Jersey and Guernsey, and ended his exploits by landing in Northumberland. He was killed in 1397 when fighting the Turks. Another launch last week was that of the submarine minelayer "La Perle," which is one of half a dozen of the same type of craft with a surface displacement of 760 tons. With a surface speed of 12·5 knots the cruising range is 2500 miles. Besides torpedo tubes fore and aft the submarine has a 75 mm. gun and a machine gun, and carries thirty-two mines.

A Locomotive Explosion.

An unusual accident occurred on Thursday night of last week to the Modane-Paris *rapide* on the P.L.M. line. Close upon midnight the train was travelling at 65 miles an hour on a straight down grade near the Tenay station, about 50 miles from Lyons, when the locomotive exploded, the boiler and fire-box being lifted bodily off the frame and projected over the telegraph wires for a distance of 360ft. The frame remained on the rails, and the train came to a standstill in about half a mile without passengers being aware that anything out of the ordinary had happened. There was a storm at the time which led passengers to believe that the noise of the explosion was thunder. The remains of the driver and fireman were found by the side of the track.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

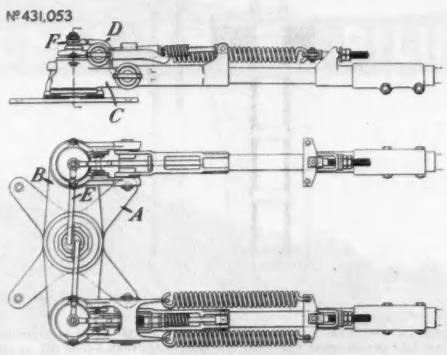
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

ELECTRICAL APPLIANCES.

431,053. December 1st, 1933.—TROLLEY POLE CURRENT COLLECTORS FOR ELECTRIC VEHICLES, The English Electric Company, Ltd., Queen's House, 28, Kingsway, London, W.C.2, and P. L. Mardis, "Lyndhurst," Sedbergh Park, Ilkley, Yorkshire.

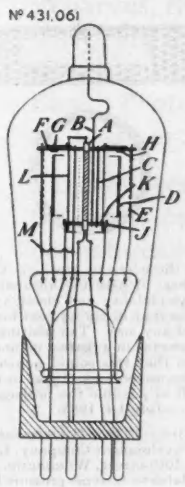
This invention relates to a double trolley mounting device and concerns more particularly the means of establishing electrical connections between two separate trolley heads and the interior of a vehicle. As the two trolley heads must be insulated from one another—usually for the full-line voltage since the two trollies usually establish positive and negative supply connections—they must be insulated from the trolley base. According to the present invention, a connector insulated from the trolley base and connecting the flexible cable running from the trolley head to the trolley base with the flexible cable coming from the interior of the vehicle in a way which



does not interfere with the swinging of the pole comprises a rotary rubbing joint concentric with the vertical pivot of the pole. Pivotally mounted on a vertical spigot forming part of the base A screwed to the vehicle roof is a platform B, at opposite ends of which are pivotally mounted the pole ends C. From the cylindrical pivot portion of each pole end extends a fork which carries ball or roller bearings for the horizontal pivoting of the trolley pole. The lower end of the latter is bifurcated and the flexible cable D is led from the trolley head down through the interior of the pole and between the two limbs of the lower end thereof. Connection from the lower end of the flexible cable to the interior of the vehicle is made by the flexible cable E. To allow the trolley arm to turn about a vertical axis relatively to the platform B without bending either of the flexible cables, a rubbing connection is used between the two cables at F, and is insulated from the trolley base.—*July 1st*, 1935.

431,061. December 29th, 1933.—THERMIONIC VALVES, S. F. Warren, 27, Lowick-road, Harrow, Middlesex.

According to this invention in thermionic valves comprising a cathode, a control grid, a screening grid, and an anode, a further screening electrode surrounding the outer surface of the anode is provided, which is electrically connected to the inner screening grid. The inner screening grid does not extend appreciably beyond the ends of the control grid and the anode, and the lines of force which would normally pass between the control grid and the anode around one or both ends of the screening grid are screened off by means of one or more end screening members insulated from both the screening grid and the external screening electrode. These end screening members may be in the form of metal end discs, and may be connected to earth, to the cathode of the valve, or to some other point, preferably

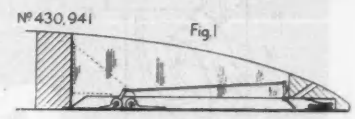


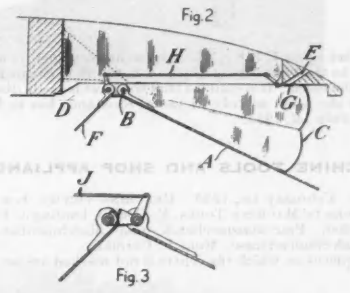
at a low potential. The electrode system comprises the cathode A, shown as an indirectly heated cathode, surrounding which are the control grid B, the screen grid C, and the anode D, and, outside the anode, a further screen E. The electrodes are supported in spaced relation at their upper end by means of a disc F, of mica or other suitable insulating material, upon which is mounted a metal disc G, which is fastened thereto by means of clips H or in any other suitable manner. The disc G, it will be seen, has an aperture in its centre sufficiently wide to enable the support wires for the screen grid C to pass through the disc without making electrical contact with the disc. Furthermore, the disc is smaller in external diameter than the screen E, and accordingly does not contact therewith. At the lower end of the electrode system there is provided a tubular member J, in which is formed a rebate supporting a second disc K of mica or other suitable material, in which the lower ends of the cathode, control grid, and screen grid, are secured. The tubular member J is supported from the pinch on suitable support wires. Extending upwardly from the member J are one or more wires L, by means of which this member is connected to the upper disc G. Furthermore, one of these wires may serve as a lead to the cathode A. The external screen E is connected by the wire M to the screen grid and therefore receives a high potential.—*July 1st*, 1935.

AERONAUTICS.

430,941. June 8th, 1934.—WING FLAPS, Boulton and Paul, Ltd., Riverside Works, Norwich.

The flap A is hinged at its forward edge to the wing of the aeroplane on the pivot B. Its sides and rear edge are connected with the wing by bellows C. The cavity thus formed is in communication with an area of high air pressure through the opening D and with one of low pressure through the passages E. The openings are controlled by flaps F and G, which are inter-



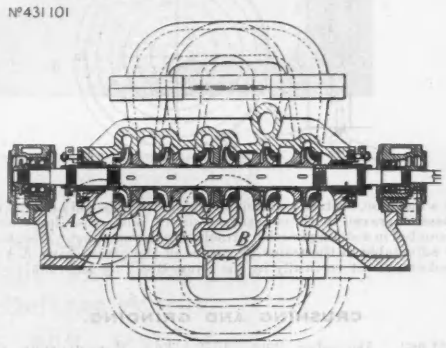


connected by the rod H. The hinges of the flaps A and F are geared together by toothed quadrants, as shown in Fig. 3. In normal flight the flap A is held flush with the underside of the wing by the suction through the passage E (see Fig. 1). When it is desired to use the flap, the pilot pulls the rod J (Fig. 3) and opens the flap F and closes G. The high pressure then distends the bellows and the flap A is kept open (see Fig. 2).—*June 27th*, 1935.

PUMPING AND BLOWING MACHINERY.

431,101. August 29th, 1934.—MULTI-STAGE CENTRIFUGAL PUMPS, *Worthington-Simpson, Ltd., Lowfield Works, Newark-on-Trent.*

In order to minimise the difficulty of making a tight joint where the impeller shaft emerges from the pump casing the first and second stages are arranged at opposite ends, so that the

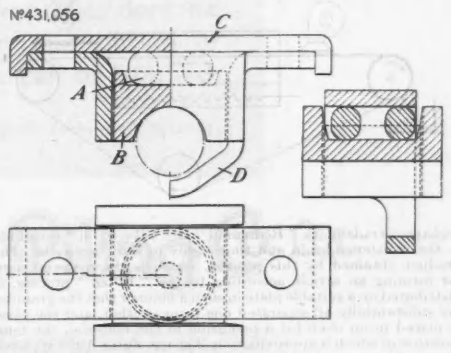


packings are subjected to the lowest pressure possible, and for the purpose of balancing the end thrust of the impellers those on opposite sides of the centre line are arranged facing in opposite directions. The chambers of the various impellers are connected together by means of outside pipes, as shown in the drawing. A is the suction and B the delivery.—*July 1st*, 1935.

MINING MACHINERY.

431,056. December 27th, 1933.—PIT TUB AXLE-BOXES, Robert Morris, Ltd., Farnworth, Bolton, Lancs.; C. H. Taylor and N. R. Maxwell.

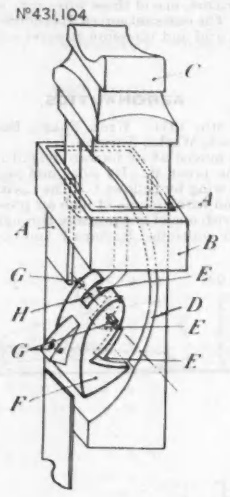
The inventors employ rubber pads A between the axle bearing



B and the base-plate C. A strap D is bolted up beneath the axle, but does not touch it. The base-plate is turned down at the ends to take end thrusts.—*June 27th*, 1935.

431,104. October 10th, 1934.—Pit Props, P. Perrin, 55, Marché aux Chevaux, Bethune (Pas de Calais), France.

This is a telescopic prop formed by a pair of channels A A secured together by bands, one of which is shown at B. The head C is of cast steel and is recessed at D. In this recess there

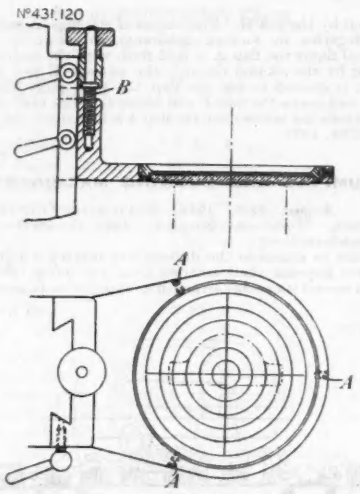


are ratchet teeth E E E. These teeth are engaged by a pawl F pivoted to the channels at G G. A notch H is cut in the pawl to pass the teeth. It is claimed that the pawl is easily disengaged to lower the prop, as only frictional resistance has to be overcome.—*July 1st*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

431,120. February 1st, 1935.—Centring Device for Workpieces in Machine Tools, F. Deckel, trading as Friedrich Deckel, Prazisionsmechanik und Maschinenbau, 7–13, Waakirchnerstrasse, Munich, Germany.

Workpieces on which the centre is not marked are set in place

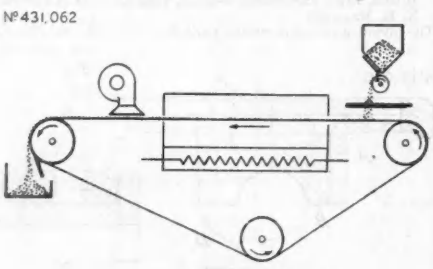


in a machine, such as a milling machine, with the aid of a disc of glass engraved with concentric circles and cross lines and mounted in a sliding bracket attached to the machine. The glass is adjustable in the frame by means of the grub screws A A A and can be set vertically by the screw B.—*July 1st*, 1935.

CRUSHING AND GRINDING.

431,062. December 29th, 1933.—The Manufacture of Bonded Abrasive Articles, The Carborundum Company, Ltd., Trafford Park-road, Trafford Park, Manchester.

According to this specification, the material for making abrasive wheels comprises, for instance, 880 parts by weight of No. 36 grit fused alumina abrasive grains made wet with 30 parts by weight of a liquid phenol condensation product resin, such as that known under the registered trade mark "Redmanol" as "No. 1375." After mixing carefully to assure a substantially uniform distribution of the liquid over the grains, 90 parts of the finely powdered fusible and soluble phenolic condensation product resin which is known under the

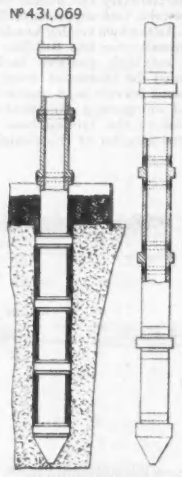


registered trade mark "Redmanol" as "CR=0214," are added to the moistened grain and thoroughly mixed therewith. The product obtained by this process, which is the material used for forming an article according to the "Robie" process, is distributed on a suitable plate in such a manner that the granules are substantially all separated one from another, and the plate is placed in an oven for a precuring of the material, the temperature of which is approximately 350 deg. Fah. After approximately 2½ minutes' exposure to the temperature in the oven, it will be found that the previously solid resin has melted and become homogeneously mixed with the wetting solution, and the granules are then removed from the oven and cooled to room temperature. In making up an abrasive article, this intermediate product is moistened with about 1 cubic centimetre of the resin solvent, such as benzaldehyde, and the mixture, which is entirely granular and not perceptibly adhesive, is placed in a suitable mould and pressed at approximately 2000 lb. per square inch. The formed article is removed from the mould, placed on a steel plate, and cured to final form by placing in an oven, the temperature of which may be initially about 250 deg. Fah. The temperature of the oven is then raised to 350 deg. Fah. at the rate of about 25 deg. Fah. per hour, and is maintained at this value for about ten to fifteen hours, depending upon the size of the abrasive article. After curing, the article may be cooled and subsequently finished in the usual manner. The illustration shows the travelling band oven which is used for baking the material.—*July 1st*, 1935.

BUILDING.

431,069. January 1st, 1934.—Concrete Piles, A. G. Rotinoff, Regent House, Kingsway, London, W.C.2.

The invention comprises the formation of the pile shoe and of parts of sections or between sections of the pile of larger diameter than the remainder of the pile, and the provision of an enclosure containing gravel, ballast, concrete, or other filling material,

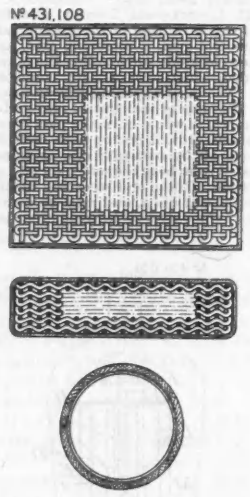


through which the pile is driven into the earth, so that after the shoe has penetrated the soil, the filling material will fill in the annular spaces between the parts of the pile of larger diameter, and be driven into the ground simultaneously with the pile in order to increase the frictional grip of the pile and consolidate the soil around the pile. The illustration shows two alternative designs of pile.—*July 1st*, 1935.

MISCELLANEOUS.

431,108. October 29th, 1934.—A Non-conducting Covering for Sound, K. Weber and the Norddeutsche Asbest-u. Gummiwerke Kurt Weber and Co., G.m.b.H., No. 8–14, Wendemuthstrasse, Wandsbek, Germany.

The sound non-conducting covering, according to this invention, consists of crosswise intertwined strings of loose porous amosite asbestos or asbestos spinning fibre, which, plaited like a wicker-work, are enclosed by a cover having a greater stiffness than the strings of loose porous asbestos and connected with



this cover only on the edges by sewing. Owing to the intertwining of the strings of asbestos internal displacements are excluded and the yieldability and elasticity of the insulating cover is preserved so that it can be used for covering round or irregular surfaces of any size. The plaiting of strings of loose porous asbestos intercepts in a perfect manner any sound waves and damps them so that this sound non-conducting covering is chiefly suitable for use on men-of-war in which it is essential to prevent as much as possible the propagation of the engine and exhaust noises.—*July 1st*, 1935.

431,434. July 23rd, 1934.—High-pressure Lubricants, Standard Oil Development Company, Linden, New Jersey, and 100, West 10th-street, Wilmington, Delaware.

This invention relates to extreme pressure lubricants. Among the compounded oils that have been proposed for carrying intense loads are those comprising a hydrocarbon base oil and a sulphur-chlorine compound, for example, a compound prepared by treating a fatty oil with sulphuryl chloride. These are fully capable of withstanding the pressures and otherwise give good lubricating characteristics, but there are objections which have limited, if not prevented, general use. The main objection is that the compounded oils as ordinarily prepared are corrosive, and since it is impossible to avoid small quantities of moisture, this results in discoloration of the gears and other mechanism, and in time corrosion, pitting and rusting. Further, as a result of this corrosive action, there are formed oil-insoluble abrasive materials which materially lower the lubricating value of such blends. According to the invention, there is used a composition of the sulphur-chlorine type, which, while carrying the load, only corrodes or rusts steel surfaces to a limited degree and then for only a period of time which is short enough to be tolerated. Furthermore, the present composition is effective over substantially the whole life of the oil, while in the case of many prior compounds the valuable load-carrying properties are lost after a relatively short period. In the present high-pressure lubricant use is made of a hydrocarbon base oil which is selected for the particular use to which the lubricant is to be adapted. Its viscosity is ordinarily above 90 seconds Saybolt at 210 deg. Fah. and may be in excess of 200 or even 300, depending on the particular service. The oil may be derived from a naphthenic or a paraffinic crude and the cut may be a distillate or residue as desired. The flash point is ordinarily not of much significance for transmission oils, but it is usually above 400 deg. Fah. or 450 deg. Fah. or even higher. The present lubricants may be liquid or they may be solidified, in which case aluminium, soda, or lime soaps, such as those derived from tallow, stearic acid, and the like, may be added in proportions ranging from 10 to 50 per cent. The sulphur-bearing compound is of the type described as "corrosive," which means that it discolours a bright copper strip immersed therein, but it in fact has no appreciable action on steel gears or metal containers in which it is kept. The amount of "corrosive" sulphur in the blend should be in excess of 0·2 per cent. and ordinarily from 0·30 to 3 per cent. or thereabout. (The percentages given refer to the amount of "corrosive" sulphur and not to the amount of sulphur compound.) Various compounds of sulphur may be used, but it should be understood that sulphur exists in "non-corrosive" as well as "corrosive" forms and therefore it is desirable to determine the amount of "corrosive" sulphur and to blend on this basis. "Corrosive" sulphur may be determined as the difference between total sulphur in two samples, one of which has been deprived of "corrosive" sulphur by digesting the same with a finely divided metal, for example, copper, over a period of several hours at steam bath temperature. Its sulphur content may be determined by any standard method, for example, by the method devised by the American Society for Testing Materials, D—129—27, described in report of Committee D—2 on Petroleum Products and Lubricants and Method of Tests relating to Petroleum Products, page 174, 1928. As to the sulphur-containing compounds, fractions from certain crudes known to contain "corrosive" sulphur may be used, and, as an example of these, residues from West Texas may be given, it being understood that other known crudes of the type may be used. Elemental sulphur may be added, alone or to fortify the other "corrosive" sulphur present. Animal, vegetable, and fish oils may be sulphurised by treatment with raw or elemental sulphur at elevated temperatures. Organic poly-sulphides may also be used. For example, they may be prepared by chlorination of a mineral oil or wax by bubbling chlorine therethrough for a period of several hours or until it contains from 5 to 30 per cent. chlorine. The chlorine may then be substituted by sulphur through the reaction with alkaline polysulphides, for example, sodium or potassium polysulphides. In this way chlorine may be entirely displaced from the compound. It is important that the chlorine compound should be added separately, or in other words, that both the chlorine and sulphur be present in different compounds. This is important, for it has been found that chlorine-sulphur compounds, for example, those produced by treating fatty oils with sulphuryl chloride, gradually lose chlorine in use, and when chlorine is lost the sulphur is unable to carry the extreme pressure loads. The exact *rôle* of the chlorine is not understood, but it is believed to be in the nature of an activator and that in some manner it permits the sulphur to "take hold" gradually so that the friction load curve is smooth and without sharp breaks. Whatever the action may be, its effect is permament, in spite of the gradual loss of chlorine; for example, it has been found that in automobile transmissions after 100 or 200 miles the chlorine content has greatly diminished and after 400 to 500 miles it has completely disappeared. This corresponds to a running-in period of from ten to fifteen hours' use. The sulphur content is intact and it has remained in a "corrosive" form. The oil, even after loss of chlorine, is capable of withstanding high bearing and tooth pressures.—*July 8th*, 1935.

LAUNCHES AND TRIAL TRIPS.

Manchester Port, single-screw steamer; built by the Blythswood Shipbuilding Company, Ltd., to the order of Manchester Liners, Ltd.; dimensions, 430ft. by 57ft. by 38ft.; to carry cargo. Engines, single reduction geared turbines of Parsons' type, pressure 225 lb. per square inch; constructed by David Rowan and Co., Ltd.; launch, July 30th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Robey and Co., Ltd., of Lincoln, inform us that the scheme of reorganisation, sanctioned by the Court, has been duly completed, and that on July 30th last the Receiver was discharged. The company's organisation has been fully maintained, and it is in a position to carry out contracts of any magnitude in the same manner as heretofore.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The Associated Equipment Company, Ltd., has received from Leeds Corporation an additional order for ten A.E.C. "Regent" double-deck oil-engined buses. This will bring Leeds' A.E.C. bus fleet up to 114, of which 72 per cent. are of the compression-ignition type.

The Hydraulic Coupling and Engineering Company, Ltd., of Isleworth, has received from the Western Australian Government Tramways and Electricity Supply Department an order for fluid couplings for the power transmission and speed control of the boiler fans, feed pumps and coal pulveriser units at the East Perth Station.

Petters, Ltd., have received orders for one 400 b.h.p. engine for a Canadian generating station, for four engines aggregating over 1000 b.h.p. from a South American mine, for two engines of 270 b.h.p. for an African gold mine, and for other engines, including two four-cylinder, direct-reversing units, each of 300 b.h.p., for installation in tugs.

The Cambridge Instrument Company, Ltd., has received a contract through Richard Costain, Ltd., of London, for supplying to the Childerditch Brickworks, Brentwood, Essex, a comprehensive outfit for the measurement of kiln temperatures, &c. The outfit comprises both thermo-electric and distance thermometer installations, the latter being for the temperatures in the tile plant. The kiln temperature installation includes three six-point recorders, three six-point totally enclosed indicators, eighteen "Titan" thermo-couples, and fifty-four two-hole sockets enabling the thermo-couples to be used for different chambers. The electrical distance thermometer outfit for the tile plant comprises a three-point thread recorder, a totally enclosed indicator, and three hermetically sealed resistance thermometers.